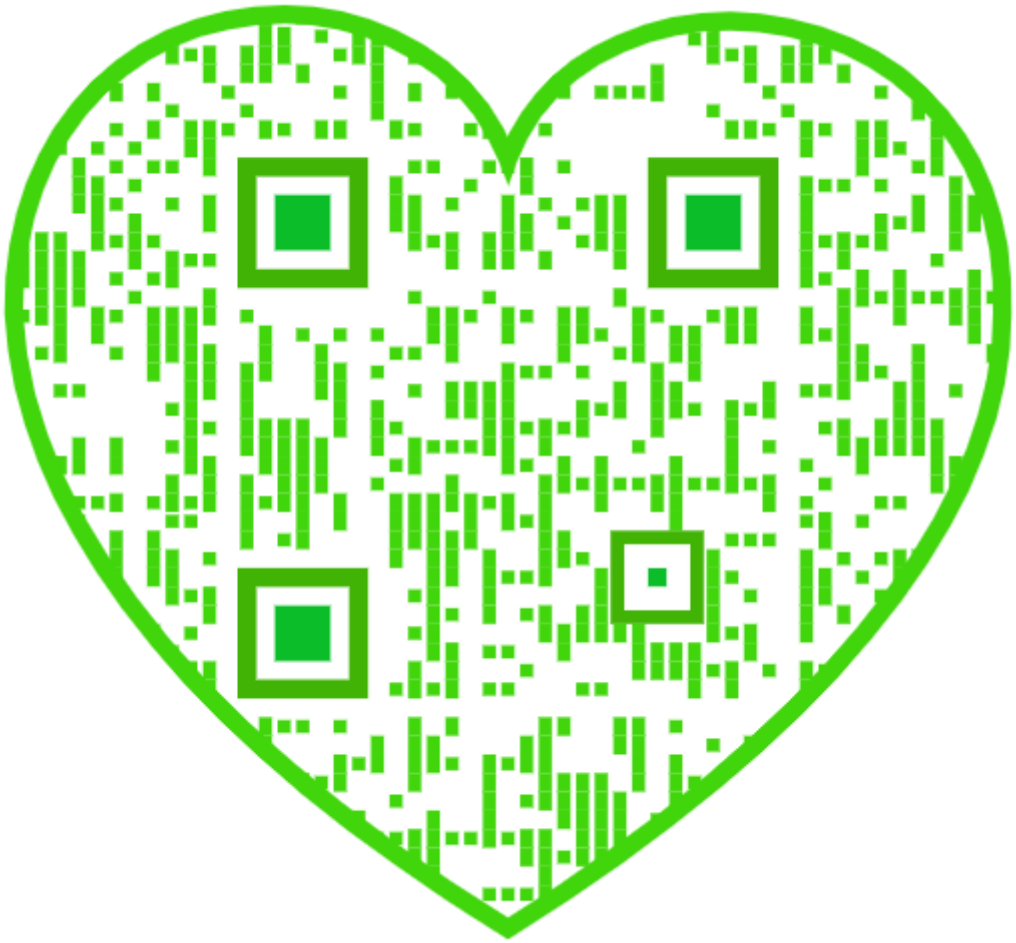

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THE

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Contents.

	PAGE
The Nomenclature of Semi Steel	23
Variations in the Mechanical Properties of Metals and Alloys at Low Temperatures	23
Specification of Bull-Head Rails	24
Correspondence	24
Book Reviews	24
Iron Foundry at Hecla Works, Tipton	25
Die Castings and Alloys for Fine Mechanisms	26
European v. American Moulding Machine Practice	26
Discussions on the Birmingham Conference Papers	27
Some Influences of Low Temperature on the Strength and other Properties of Cast-Iron	32
Systematic Gating	36
Institution of British Foundrymen	37
Three Months Variations in Prices	37
Moulding Barrel Castings	38
Establishing a Method of Testing for Green Bonded Strength	38
Iron and Steel Markets	39
Trade Talk	40
Gazette	40
Company News	42
Personal	42

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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The Nomenclature of Semi-Steel.

As was expected the appellation "semi-steel" was adversely criticised at the Birmingham Conference, but no substitute which had the slightest chance of general acceptation by the English-speaking nations was put forward. More than a year ago we suggested the coined word "Fontoid," which received kind criticism but no acceptation. Professor Turner suggests "Toughened Cast Iron." Dr. Moldenke's Committee put forward "High-test Cast Iron," and Mr. S. G. Smith alludes to "Steel Alloy."

Professor Turner's suggestion is open to criticism on the ground that other methods and mixtures can also produce a toughened cast iron, for example, electrically-manufactured cast-iron produces a material akin to that made from steel and pig-iron mixtures, which have been cupola-melted. The title, "High-test Cast Iron," is subject to similar criticism, as again no reference is made to the essential factor, which, after all, is in origin the incorporation of steel.

Mr. Smith's suggestion, "Steel Alloy," gives to the mind the same impression as semi-steel, with the exception that the latter phrase may be taken by some people to relate to a 50 per cent. mixture. Our own suggestion, Fontoid, is no worse or not better than any other coined word based on foreign languages. Now that everybody has decided that semi-steel is an unsuitable term, we propose to put forward some of the many factors which exist for its retention, in order that its condemnation does not become parrot-like.

First and foremost, there is the right of common usage—a factor of supreme importance. Secondly, it denotes, when considered as an adjective qualifying the understood word "cast-iron," the indirect cause of the enhanced mechanical properties. That there is much good ground for such treatment is amply demonstrated by reference to metallurgical trade terms, some of which show process origin and some future use. For instance, "basic steel" refers to the process of its production, for steel, *per se*, can never by any stretch of imagination be sometimes acid and sometimes basic. Obviously the word "process" is understood. On the other hand, "basic iron" denotes its suitability for use in basic furnaces. Really, its impurities are acid, since they are removed under a basic slag. Now, semi-steel cast-iron, to give its full title, denotes that a considerable quantity of steel has been used in its manufacture. We see no objection to its use when regarded in this light, especially if preceded by a qualifying figure denoting the percentage of steel, such as 25 per cent. semi-steel cast-iron. We are well aware that standard dictionaries define semi- as a Latin prefix denoting half, but right of common usage, which is a difficult obstacle to surmount, has modified its use to signify "something in between." Thus, when a person is semi-conscious, there are unlimited degrees of consciousness. Semi-washed, semi-bituminous are other illustrations where the implied "half" is very variable. Therefore, it is admissible to qualify and make definite the quantity of steel used in the manufacture of semi-steel cast-iron. It will thus be seen, if only the foundry world can be induced to regard the word semi-steel as an adjective, the major portion of the fabric built up against its use is destroyed. We shall be happy to hear critics use the expression "universally-accepted" instead of the "so-called" term semi-steel. We feel confident that they are only fighting against the inevitable.

Variations in the Mechanical Properties of Metals and Alloys at Low Temperatures.

Messrs. Leon Guillet and Jean Cournot have carried out investigations to determine the Brinell hardness and notch-impact strength of various metals at low temperatures, the tests having been made at + 20 deg. C., — 20 deg. C., — 80 deg. C., and — 190 deg. C. The test-pieces were maintained at these temperatures 15 hours before being tested. The results showed (1) a gradual increase in hardness towards the lower temperatures. (2) That brittleness at lower temperatures is characteristic of ferrite. The greater the quantity of ferrite the more rapidly the notch-impact strength diminishes with the temperature. Nickel and copper do not exhibit these phenomena. Aluminium, on the other hand, appears to become tougher at lower temperatures. Pure austenite rich in nickel also exhibits no brittleness at low temperatures. (3) The pearlitic nickel-steels exhibit at — 190 deg. C. great brittleness, which seems to diminish as the percentage of nickel increases. The test samples recovered their normal properties when kept for 24 hours at + 20 deg. C., after having been kept at —190 deg. C. for 16 hours.

Specification for Bull-Head Rails.

The British Engineering Standards Association has just issued a revised Specification for bull-head rails (Report No. 9, 1922). This is the second revision of the Specification originally published in 1904, and embodies the alterations which experience has shown to be desirable to meet present-day requirements. The following are some of the more important modifications made:—

Two classes of steel are now included, namely, ordinary carbon and high-carbon steel, and separate chemical analyses are specified for Bessemer and open-hearth steels. The position in the head of the rail from which the drillings and the test pieces for the chemical analyses and tensile tests respectively are to be taken is now defined.

In the falling-weight test the use of crop ends is permitted, and the measurement of permanent set after the first blow has been omitted. The test is required to be carried out on the British standard testing machine, the specification for which is inserted as an Appendix. The height of the drop for B.S. Section No. 90 has been reduced to 18 ft. (5.49 m.).

The range of ultimate tensile strength for ordinary carbon rails, namely, from 40 to 48 tons per sq. in., has been increased to from 42 to 53 tons per sq. in., and a range of tensile strengths for higher carbon rails inserted (46 to 55 tons per sq. in. for acid or basic open-hearth steel, and from 44 to 53 tons per sq. in. for acid Bessemer steel).

The testing procedure before rejection has been set out in detail. Provision is made for ascertaining the weight of the rails during rolling. The mark of the Association is now only intended to indicate that the rail is of British Standard section. An arbitration clause has been included.

The Report gives full-size diagrams of the British Standard rail sections ranging from 60 to 100 lbs. per yard, and the only departure made from the original standards is in the case of the 85-, 90-, and 95-lb. rails, in which the depth of the head has been increased by 1/16 in., 5/64 in., and 1/32 in. respectively, with the object of securing a longer life, a corresponding amount being taken off the bottom in each case in order to preserve the same weight and depth of the rail. To distinguish the revised sections from the older sections, the former have been designated 85R, 90R, and 95R respectively.

Throughout the Specification and on the diagrams approximate metric equivalents of the British measures have been added for the convenience of users in countries in which the metric system has been adopted, but it is clearly laid down that the figures in British measures are to be regarded as the standard.

Copies of the Specification, 1s. 2d. post free, can be obtained from the Association (28 Victoria Street, Westminster, S.W.).

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

National Foundry Competitions.

To the Editor of The Foundry Trade Journal.

Sir,—I was very surprised to find that in the coremaking section at the Foundry Trades' Exhibition, only one particular make of core-oil was allowed to be used.

To my mind much valuable information to iron-founders was lost through not having all kinds of core-oils "on tap" for the use of competitors.

The object of the exhibition, as I understand it, was to improve the status of the foundry trade by the exhibition and demonstration of improved appliances and methods of manufacture.

Core-sand mixing is one of the operations of which so very little is known by the average foundryman, and I am amazed that the Committee responsible for the competitions allowed such a golden opportunity of demonstrating the mixing of core-sand with the various core-oils on the market, by experienced coremakers, to slip past them.

In addition to this, the fact that only one core-oil was used, destroyed the value of the competition, as competitors did not have equal chances, the competitor who had experience with the particular core-oil used having an unfair advantage, and I have reason to believe that the results of the competition bear this out. Also, the fact that only one particular brand of core-oil was used suggests either partiality on the part of the Committee or that the core-oil firm concerned, have a good publicity agent, as the particular core-oil has no special advantages, to my mind, over many other core-oils which were advertised at the exhibition.

Another point on which I should like some explanation from the Committee is that one coremaker (A) sent in his application to enter for Class A, Section I, *in the same envelope* as another coremaker (B). Coremaker (B) received his instructions to attend on a certain date, when he competed, but Coremaker (A), who is the best oil-sand coremaker I have ever known, received no communication whatsoever, and consequently did not compete.

Trusting you will give publicity to this letter in your valuable Journal, and enclosing my card.

I am, Sir,

Yours, etc.,

"Old Bill."

Book Reviews.

Capstan and Automatic Lathes, by Philip Gates. Published by Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 2s. 6d. net.

This little book is another of Pitman's Technical Primer Series, and should be useful for pattern makers and, to a lesser extent, foundry foremen, as the author has presented the subject in such a manner as to assist every reader having an interest in the production of interchangeable work. Primarily, of course, it is written for those whose work is actually to set the necessary tools and attend to them when the machines are in motion. The book is very suited for technical schools as a textbook for first- and second-year men.

Notes Economiques d'un Metallurgiste (1915-1921), by Camille Cavallier, Forge-master, President of the Nancy Chamber of Commerce. Published by Gauthier-Villars & Company, 55, Quai des Grands Augustins, Paris. Price, 3.50 francs.

This work, which admits of the rough translation of Some Notes on Economics by an Engineer, is based upon a series of notes taken during and after the war relating to economical questions appertaining to French industries, particularly the metallurgical ones.

The author first makes a comparison between French and German industries from the export point of view, after which he deals with the question of the participation of large manufacturers in politics. After a discourse on the relationship of the proprietors of works with capital and labour, the author submits an analysis of the economic crisis under which the world has laboured for the last two years, clearly exposing the causes and pointing out the necessary remedies.

Mr. Cavallier's book will be a real interest to those of our readers possessing a knowledge of French, as it is always interesting to get the "other fellow's" view, especially when it relates to matters which are of direct concern to this country.

The Milling of Sand.—In our issue of May 4, under the above caption, we described and illustrated a new design of wheels suitable for the milling of moulding sand. We now learn that the inventor, Mr. F. Andrews, has been granted a patent (No. 173,438) and that he has confided the manufacturing and selling rights to Messrs. John Barnsley & Sons, Limited, engineers and iron-founders, of Nethorton, near Dudley.

Iron Foundry at Hecla Works, Tipton.

Messrs. Nortons (Tividale), Limited, Hecla Works, Tipton, Staffs, had experienced considerable difficulty in obtaining suitable castings to meet the ordinary demands of the works; indeed, this was frequently the factor which determined the time of delivery. To overcome this difficulty, as also to meet the increased demand for castings on account of new developments, the management determined to build a foundry.

The foundry building forms a right-angle to the main shops, into which there are gateway entrances, and on the opposite side is bounded by an arm of the canal, the position securing at the same time ideal facilities for handling the raw material and a completion or a continuity of the works. The foundry building, which is 120 ft. × 40 ft. × 30 ft. high to the eaves, is built of brick, with a glazed roof and a temporary end to facilitate extensions. The floor is served by a 3-ton electric crane, constructed by the Company's staff. The stocking ground adjacent to the canal is served by a 60 ft. electric jib crane, provided with a 2-ton electric magnet. This crane not only handles the material on the stocking ground, but also serves the charging platform for the cupolas, and the sand hopper which is placed above the sand-mixing shop.

Fig. 1. View in the Main Bay of the Foundry.—Messrs. Nortons (Tividale), Limited, Tipton.

Fig. 2. A Corner of the Foundry.—Messrs. Nortons (Tividale), Limited, Tipton.

The foundry is served by two cupolas with melting capacities of 5 tons and 30 cwts. respectively. Blast

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is supplied by Keith-Blackman fans driven by 20-h.p. and 10-h.p. motors; the fan outlets, however, are cross-connected, so that either fan can do duty for either cupola. The charging platform is very liberally proportioned and affords storage for about 100 tons of pig and scrap and 40 tons of coke. The platform is under roof. The sand-shop equipment includes a Britannia sand mixer and a sand grinder, which are driven by belts from a 25-h.p. motor.

Castings are made in green sand, dry sand, and loam. In the main foundry two Adaptable moulding machines are installed, one plain and one turnover, supplemented by a Duncan-Stewart wheel-moulding machine for moulding gears up to 10 ft. in dia. The drying stove is of an American type 20 ft. × 10 ft. × 8 ft., and side by side with it a second stove 30 ft. × 10 ft. × 8 ft. The stove is of the double-eased type, heated by underground flues and fired from an independent furnace, the flue plates being removable so that the hot air may be short-circuited when desired. A steel stack, part brick-lined, 60 ft. × 3 ft., serves the two stoves. This type of stove has proved very economical in operation, requiring only 4 cwts. of coke mixed with a barrowfull of rough slack for 24 so that the hot air may be short-circuited when desired. serve the stove. The core shop is in an annexe. The benches are a notable feature in this shop, being covered with cast-iron plates with planed surface, thus eliminating the use of separate plates for knocking up. The cores are dried in a coke-fired stove by Ballard & Company, Limited, Tividale, Staffs.

Adjoining the main building is a shop 40 ft. × 26 ft., in which the light castings are made; this shop is furnished with 3 Britannia jar-ramming machines. The fettling shop adjoins this last, and contains the usual equipment of pneumatic chippers. emery grinders, etc., whilst in an annexe is a Britannia compressor which supplies the power to the pneumatic tools, as also the jar ramming machines. In the fettling shop is also a Hodgson and Stead 5-ton weighbridge. The fettling shop has a gateway communication with the yard, and as the crane runways which serve the main machine shop extend over the fettling shop, the castings can be picked up and conveyed direct to the machines or loaded into wagons for direct despatch, as the case may be. The foreman's office is in a mid position, so that he has a clear view of both foundries and fettling shop. As the foundry is for all practical purposes run as an independent works, a separate building has been provided for the foundry manager's office and foundry drawing office. The pattern shop and pattern stores replete with the usual complement of tools, are housed in shops whilst adjacent to the foundry.

In addition to supplying the demands for castings for the works the foundry is engaged upon the production of general castings for the trade in weights ranging from a few pounds up to 3 tons. At the time of our representative's visit, castings were being made of moulds for rubber tyres. special sections of pipes and parts for gasworks and by-product plants, etc. A new line with the Company is the manufacture of pit sheaves, the first of which. 14 ft. in dia., was on the floor.

The late Mr. R. Hardy, of Swansea, chairman of R. Hardy & Company, Limited, metal merchants, left £10 088.

The late Sir John Scott, Bt., who died on April 29, left a fortune of £582,165, the net personalty being £563,034

The Structure of Coke.—Messrs. H. D. Greenwood and J. W. Cobb, in a Paper on this subject read at the Yorkshire Section of the Society of Chemical Industry, thus summarised it. The formation of high-temperature coke can be divided into three stages:—(1) The first stage up to 550 deg. C. is constituted by the initial cell formation, the cells having relatively thick walls of soft material of low specific gravity, the process being accompanied by a swelling of the charge. (2) Between 550 and 850 deg. C. the mass as a whole shrinks, and an increase in specific gravity of the coke material ensues, the resulting coke having thinner but stronger walls and the porosity reaching a maximum. (3) In the last stage the predominant factor is a further large contraction of the mass as a whole, the coke material undergoing no appreciable increase in specific gravity. We are thus left with a strong coke, constituted of small pores with relatively thick walls. At no stage in coking to 1,100 deg. C. does the material approximate to the specific gravity of graphite, 2.3. The authors have followed the process in a fairly typical gas coal, but believe that its essential features would be reproduced in the behaviour of coking coals generally. The swelling of the coal in the first stages of carbonisation is well known to cause difficulties in withdrawing coke made at low temperatures, and in producing sticking at the top of the charge in continuous vertical retorts and gas producers, particularly when fitted with a bell.

Die Castings and Alloys for Fine Mechanics.

When the use of alloys, both of the heavy metals, lead, tin, and zinc, and of light metals, for making finished castings of parts of meters and of other instruments, was discussed at Berlin in connection with a Paper by K. Kaufmann, of the Fertig-Guss Gesellschaft (*Zeitschrift für Metallkunde*, January last, pages 8 to 22), so many admissions of troubles with these castings were made by the lecturer, as well as by other manufacturers and professors, that one might feel doubtful as to the reliability of these alloys, some of which were "war substitutes." The discussion dealt in particular with die-casting prepared by forcing the fused alloy by a piston through a hole into the metal mould. But sand castings of the same alloys are also in use, and some of the "Spritzgusslegirungen" are undoubtedly promising. Thus the ample analytical detail of the various alloys given during the discussion will be of considerable interest.

The long-known castings of tin-lead alloys are not strong, have low melting points, and must not be heated above 100 deg. C. subsequently, but they shrink little and keep their exact dimensions. Pure zinc is not suitable; alloyed with tin, or with copper or aluminium, it answers; but tin and aluminium do not go together in general; tin foil containing more than 0.2 per cent. of aluminium may crumble in a few days; in complex alloys of zinc and aluminium the influence of tin is less clear. Zinc-tin alloys (for the mouthpieces and horns of telephone apparatus) should not be varnished at temperatures above 150 deg. C., lest a tin alloy sweat out in beads. The Siemens Company exhibited a great many specimens of alloys, essentially of zinc-aluminium, both sand and chilled castings, which had failed, cracked, expanded, or shrunk, and had become distorted. The Al percentages varied between 2 and 70 in these products, which contained also copper, lead, and sometimes tin. It was mentioned that in America the use of alloys of Al-Zn with medium Al-percentages had been abandoned by some firms. Some new alloys are treated with acids to produce a fairly non-corrodible surface. Ageing processes are advisable, and purchasers should receive full instructions as to the use, and be informed also as to the date when the goods were cast and after what period they might safely be mounted. That, of course, might preclude the utilisation of hastily-ordered parts. One zinc alloy containing 4 per cent. of copper, 1 per cent. of aluminium, and 8 per cent. of tin, and particularly the new durolith, the composition of which was not stated, were said to give full satisfaction as to strength, hardness, and constancy of dimensions.—"Engineering."

European v. American Moulding Machine Practice.*

By E. Ronceray of Ph. Bonvillain and E. Ronceray, Paris.

The object of this Paper is to point out by a European the relative advantages and disadvantages of the European Moulding Machines compared to the standard American machines. The author points out the relatively small use of compressed air as a motive power in European machines and the large percentages of machines which are designed to use hydraulic pressure. The reason being given that compressed air can be used only for small moulds when using pressure machines, while water pressure on the other hand utilises pressures from 750 to 1,500 lbs. per sq. in. A detailed comparison of the two power mediums follows: It is stated that it is quite usual in European practice to work 20 moulding machines at full output with a 5 h.p. pump, the main pipe being ¾ in. inside diameter. Water pressure is stated to show a definite superiority over compressed air for machine moulding, particularly in countries where coal economy is acute.

Sir Charles Parsons has had the degree of Doctor of Engineering conferred upon him by the Sheffield University.

*Abstract of a Paper presented before the American Foundrymen's Association Rochester Meeting.

Discussions on the Birmingham Conference Papers.

SEMI-STEEL.

Introducing his Paper, Mr. Cameron said the results were far better than expected with regard to the test bars. That there were only two failures was very surprising, and the material turned out day after day gave satisfaction to the people who were using it. He must say that they had the unique experience in this work of having the hearty co-operation of every man, woman, and child in the place. He also acknowledged the great help he had received from Mr. McLain, Prof Campion, ex-President Riddell, Mr. Fletcher for his valuable addition, and Mr. Shaw for his practical aid when Assistant Director at the Ministry of Munitions.

Mr. S. Flagg (United States) opened the discussion by asking whether in conjunction with the cupola the lecturer used a mixer or receiver.

Tensile Test for Cast Iron Unsuitable.

Mons. E. Ronceray (Paris) referred to certain tests mentioned in the Paper for which he appeared to be in some way responsible, but several tests had been taken, and those tests had been found entirely wrong; some of the worst tests gave good tensile results and some of the best tests gave the reverse. The tensile test was not fit for cast iron, but he fancied that the tests made in France were more reliable. He thought what Mr. Keep had done was wonderful. Mr. Keep, he believed, had, in America, made several thousand tests of high silicon iron, and while on this point he might say that his own experience was that an amount of silicon between 2 and 3 per cent. did not appreciably change the strength of the metal. He had used 3.25 to 3.50 per cent. and had not found any trouble. It was an interesting problem to find out whether more silicon than that would do any harm. He did not think it advisable always to use it, but in the case of large and small castings it would be useful to know the differences that resulted, and that they could safely put more silicon into the latter.

Size of Test-Bar Important.

Mr. J. Shaw: We are indebted to Mr. Cameron for putting before us the methods employed by his firm in attaining the reputation they have in making various castings in semi-steel. There are three points on which I would like to have further information. One of the chief claims for semi-steel is the small size and fine distribution of the graphitic carbon, this property making the metal so useful to resist pressure. In view of this fact, one would not expect a drop of about 3 tons when the tensile bar was increased from $\frac{5}{8}$ to 1 sq. in., turned down to 0.564 in. In this respect it would seem to be little better than ordinary iron. I note, however, the American Radiator Company put forward tests up to 21 tons on a bar cast $1\frac{1}{4}$ in. dia., turned down to 1.128 in. dia. The mixture was made up of, roughly, $\frac{1}{3}$ steel, $\frac{1}{3}$ pig, $\frac{1}{3}$ remelt, and the analysis was TC, 3.02; GC, 2.36; CC, 0.66; Si, 1.28; S, 0.123; P, 0.104; and Mn, 0.6 per cent. It must be remembered that most of the tests mentioned by Mr. Cameron were made on the 5-16-in. bar.

Low Sulphur Queried.

The second point noted was the very low S obtained by Mr. Cameron. To keep the S down to even 0.058, his maximum figure, denotes practice not usually attained. When it is remembered that the gain of S in good cupola practice is about 0.035 per cent., add to this the effect of extra fuel often used and the greediness of steel in a red-hot pasty condition to absorb S, it is remarkable. From some hundreds of tests taken at one prominent firm the average S was 0.112 per cent. This is round about the figure mentioned in the Paper as being obtained by other workers.

A Carbon Absorption Query.

Mr. Cameron, on page 498, gives details of several experiments that tend to show how little C is absorbed during the melting stage. On the other hand, it is difficult to understand when it can be picked up afterwards, when we remember cupolas, with tuyeres as low as possible, running all day and hardly ever botted up, the metal running into a large receiving ladle. There can be practically no contact with the bed in this case once the metal is melted. Yet the lowest recorded in that works was 2.81 per cent. The only record of a low TC that I know of was one mentioned in the January issue of The Foundry, where a firm using 50 per cent. steel, with the remaining half made up of an 8 per cent. ferro-silicon with 2 per cent. C. This metal was stated to get down to about 1.8 per cent. carbon in the middle of the blow, with 3 per cent. at the start.

High Phosphorus Considerations.

Mr. H. Field (Birmingham) described the Paper as excellent. There was a tremendous future for this high tensile metal—so-called semi-steel. Alluding to Mr. Fletcher's comments, he believed that gentleman recommended them to make a high steel mixture of 50 per cent. steel, perhaps, and to use it in further work for the purpose of making a low steel mixture. That would seem to suggest that the whole of the beneficial properties of this material was retained on constant melting. He would like Mr. Cameron to confirm or otherwise as to whether, when a semi-steel mixture was constantly remelted, it retained the properties which it had originally. He quite agreed with the lecturer as to the necessity for a high melting temperature, and the very great possibility of getting chilled metal if they were not extremely careful in this respect. This metal was much more prone to chill than ordinary cast iron of apparently similar analysis. But on one point he was not in agreement with Mr. Cameron, and he said this for the encouragement of any member who was thinking of launching out in the use of this mixture. Excellent results could be obtained with a high phosphorus metal; he had worked considerably with mixtures of this kind, and there was in his experience very little difference except in one particular between the high and the low phosphorus metals. That one difference was in regard to the transverse test. But if one wanted a high tensile strength with 1.5 per cent. phosphorus in a $\frac{3}{4}$-in. bar it was an easy matter to get 18 to 19 tons tensile. On transverse tests certainly high phosphorus metal did not give such good results. However, if one required a close grain, which was one of the principal purposes of making this mixture, high phosphorus metal gave it equally as well as low.

Properties of Remelted Semi-Steel.

Professor Turner (Birmingham) said they all felt how important the subject was. He was interested in the comments of Mons. Ronceray in reference to the proportion of silicon which was recorded by the experiments in 1885. It was definitely stated in that Paper that the conclusions related only to material of a certain composition and cast a certain size, and that fact was sometimes omitted. He was very pleased to hear the references to Mr. Keep and his work. It was his pleasure to have had him as a personal friend for a number of years, and his work in relation to silicon in cast iron was of the very highest value. The question had been raised as to the name which they should give to this material. He did not know a better name than that originally given to it by Sterling 80 years ago when he introduced this metal; he called it toughened cast iron. He made it by mixing wrought iron with cast iron, and then combining it with a certain amount of pig-iron. As to the question raised how far the properties of the metal would be retained on repeated melting, he did not think they would be retained. He suggested an explanation years ago in a discussion on the mixing of two different kinds of iron. They found with varying silicon properties which did not correspond with the chemical analysis. He suggested that the beneficial effect in the one case was due to the precipitation of the carbon in matter and form; he used then the language of the time. He should say now that it was due to the precipitation of the carbon—graphitic carbon—in the solid material. It produced a fine state of division, and did not have that brittleness and weakness which they associated with larger

flakes. The question of the proportion of silicon was not so important as that of the amount and character of the carbon. Silicon, sulphur, and phosphorus, and so forth, produced a certain balance, and it was the net result with which they were concerned. They wanted first of all the maximum amount of combined carbon the material would contain or sustain without having free cementite. So far as carbon was concerned, they wanted as much as it would stand, and the amount it would stand depended on the quantity of silicon and other elements. The next thing required was that the carbon should be of the right total quantity; it must not be too high, and it must be in the finest possible state of division which they could obtain. If they could get those things together then they obtained the best quality of iron. He thought the Paper was a valuable contribution which they should read with pleasure, not only immediately after the conference, but for years to come.

Type of Pig-Iron Important.

Mr. J. E. Fletcher (Dudley), speaking of the total carbon in the use of various kinds of pig-iron in mixture, said he thought they had some very valuable suggestions in the Paper. Those who had made semi-steel were constantly finding that the type of iron being used was of the highest importance. Mr. Cameron, in mentioning the suitability of high-carbon irons, said they might with advantage use those high in manganese, and referred to hematite irons and steel scrap generally as giving good results. Their American friends were using that type of high-carbon irons and were reaping the advantage. The remarks of the lecturer about the efficiency of the Scotch type of irons corresponded with his own experience, which was that they gave remarkably good results. His own experience in trying to mix steel scrap with cold blast iron with a low carbon content was that the results were very disappointing. He thought the whole thing seemed to point to the fact that the iron is carburised more efficiently when they had iron of a fairly high carbon of the hematite type.

Mr. F. J. Cook (Birmingham) said he would like to draw attention to one paragraph of general interest in regard to obtaining better tests by using high-class irons, including cold blast, special brands and special cylinder pigs. He had been using semi-steel and high-class cylinder irons for the last 15 years, and he could confirm what the lecturer had to say in respect of the bad effects on the tensile strength of the metal. But in dealing with Diesel engine work and liners for high superheated steam he had found a distinct advantage in the wearing properties of the metal which seemed to counterbalance the loss in strength.

Application of Semi-Steel.

Mr. Young (Newcastle) said that Mr. Cameron's paper was one that they had all been waiting for over a long period, and it could scarcely have been placed before them more lucidly. However, he considered care needed to be taken as to how they applied this so-called semi-steel. He did not think it was universally applicable to any and every casting, and as Mr. Shaw had hinted, the thickness of a casting was of very great importance as well as silicon. Going into the exhibition recently he was tackled internationally upon this semi-steel question, but he must confess that he only used it when he wanted it, and one did not want it always. The author had referred to the effect of sulphur, and gave two analyses, and stated that good metal could not be made with the amount of sulphur shown. If they looked back through the paper they would find another analysis contained a low sulphur and high manganese, but here when condemning sulphur there was no manganese. He thought the fault in this iron was with the manganese, not with the sulphur; and generally they could not make good cast iron with a low manganese content.

Melting Troubles.

Professor Campion, in his remarks, said that haphazard, unorthodox methods did not give proper results; everything must be carefully measured and weighed. The early troubles of semi-steel were not due to the steel not melting readily; indeed, it melted easily, and generally melted before pig-iron. If this point was carefully attended to, there should not be the slightest difficulty in getting a good, strong metal. On the question of the size of test bars, the casting thickness made a large difference to the strength and property of the metal. They had recently cast 1½-in. bars cut down to 1.1 in., with a strength of 18 to 20 tons.

THE AUTHOR'S REPLY.

Mr. Cameron, in reply, answering Mr. Flagg, said they had not used a receiver. They used an ordinary cupola. With a mixing ladle they could take every charge by itself, which would be impossible with a receiver. Regarding Mons. Ronceray's remarks, which were always interesting, he agreed that some of the tests and analyses given by Government departments were, to put it mildly, capable of improvement. He was pleased to hear from Prof. Turner and Mons. Ronceray that a high silicon content was not the dreadful thing that some of the ironfounders rather thought it was. As to Mr. Field's question whether semi-steel retained its properties after remelting, he believed some firms were using refined iron by a process of putting large quantities of steel chain into the blast furnaces. The practice of melting semi-steel mixtures in the cupola and remelting it had been followed with very good results, but probably if it was remelted too frequently it would deteriorate, as Prof. Turner said, and the sulphur would be absorbed. But to a limited extent remelting was useful in his experience. No doubt Prof. Turner's remarks about cast iron would go to the proper quarters. Turning to Mr. Fletcher's comments, he wished to emphasise that in 1918 ironfounders took whatever iron they could get; they were not allowed to use hematite. The great difficulty was that it was practically impossible to work to a uniform analysis; the chief thing being to produce these munitions at the necessary tensile strength, which was the Government test, and, he might also say, the ultimate test of these castings was fragmentation, as to which this metal gave excellent results. The Scotch irons used worked beautifully with steel scrap. Commenting on Prof. Campion's remarks, he hoped in the near future to make some real systematic research in regard to this material, particularly with respect to the relation of carbon to silicon, and so forth.

A Written Opinion.

Mr. S. G. Smith, in a written contribution, congratulated Mr. J. Cameron upon the very able Paper dealing with added mild steel to grey cast-iron mixtures, and stated that the use of such mixtures is by no means modern. It is just 48 years ago during his foundry apprenticeship that his firm poured such castings as guides for wire mills and guide plates for small merchant mills. These castings were subject to very high frictional wear, and if made from ordinary cast-iron mixtures as was then used their life of service was very short indeed. The steel in the form of rail ends, plate scrap, etc., was put into the cupola with the last charges of metal. No record of percentages was kept at that time, as foundrymen in those days did things and said nothing, and he still had great admiration for foundrymen who were elderly when he was a boy for what was accomplished by them.

Mr. Cameron's opening statement truly says that the appellation "semi-steel" is misleading. He agreed with him. It is high time that this product should have a suitable name and specification. Text-books infer that iron containing more than 2 per cent. carbon is cast iron. The unsuitability of the name semi-steel brought an incident to his mind which occurred about five years ago. The engineers in a large engine-building concern, who had heard, or read, something about semi-steel being a good material for resisting to superheated steam, inquired what should be the analysis of semi-steel. Without giving a thought for what purpose this was required, the analysis given was based upon the percentages of constituents of an average steel, and an average foundry iron put together and halved.

Shortly afterwards, a specification came from the engineers' office to the foundry that the analysis of certain castings must comply with the specification, which gave the total carbon a little above 2 per cent. Nothing more need be said, as it is common knowledge that it is very rare,

regardless of percentages of steel put through a cupola, that total carbon will be less than 3 per cent.—more often it is well above that figure.

Whilst Mr. Cameron states that semi-steel does not displace steel or malleable cast iron, he thought there may be exceptions to this. There is a mixture of cast iron called "steel-alloy"—a much better name than "semi-steel." He knew of castings which were formerly made in steel and are now made in steel-alloy, the results being most favourable in every way. The castings referred to are comparatively thin—about half-inch section, and pass through an annealing process.

In the Paper it is stated that semi-steel is much superior to grey iron for machining. To this he could not agree. His experience with many mixtures of cast iron was that castings poured into iron permanent moulds (when not chilled) gives a perfect surface, regardless of the fineness of the thread. Also, this perfect surface can be obtained from suitable mixtures of cast iron not poured into permanent moulds. Additionally, a claim is quoted that semi-steel is a self-lubricating metal. This, he thought, was too good to be true. The quality of self-lubricating is more probable in castings containing a high total carbon, say 4 per cent., and a low combined carbon, say 0.04 per cent.

On page 497 the author states that semi-steel does not owe its qualities to chemical analysis so much as its physical structure. Surely Mr. Cameron will agree that those remarks apply to most mixtures of cast iron equally as well as steel-added mixtures.

Regarding the tests, he hoped that foundrymen were not making a lash to be whipped with. It is not often that the physical qualities of a test-bar clearly indicate the suitability of metal for castings they are supposed to represent. He would like to enlarge a little upon this aspect, but as the matter is now under consideration, and that he was serving on a branch committee, he did not propose to pursue the matter at present.

On page 498 reference was made to a bar cast from white iron and steel scrap being twisted after prolonged heating. He thought this was quite common in malleable-iron foundries.

The information given upon cupola practice he was quite in agreement with. Strange to say, the matter coincides in a remarkable way with an article prepared by myself upon that subject for THE FOUNDRY TRADE JOURNAL, and appeared in that paper twelve years ago.

The following are four results taken from numerous mixtures of cast iron and steel.

Mixture No. 7.—Steel 90 per cent., and No. 3 hematite pig 10 per cent. This gave a metal of the following analysis:—

C.C., 3.98; Gr.C., nil; Si., 0.13; Mn., 0.45; P., 0.034; and S., 0.171 per cent. The diameter of the cupola was 72 in. The steel scrap was composed of borings, turnings, billet ends, and miscellaneous material. The fracture was white.

No. 2 Mixture.—Cold-blast iron, 25 per cent.; No. 3 foundry pig, 25 per cent.; foundry scrap, 25 per cent.; and steel shells, 25 per cent.

On analysis this mixture gave C.C., 0.705; Gr.C., 2.80; Si., 2.031; Mn., 0.62; P., 0.23; and S., 0.124 per cent.

The transverse test gave 3,430 lbs. breaking load associated with a deflection of 0.09 in., whilst the tensile test registered 8.84 tons per sq. in. In this case the diameter of cupola was 60 in.

The object of this test was to attempt to minimise the growth and pitting in castings due to impinging of superheated steam. It should be pointed out that the low tensile test was probably due to the addition of steel to a strong iron, however the material was suitable for the purpose desired.

Nos. 3 and 4 Mixtures.—No. 3 foundry pig, 50 per cent.; steel scrap, 50 per cent. In this case the analyses were respectively: C.C., 1.58; Gr.C., 1.45; Si., 1.29; Mn., 0.36; P., 0.89; and S., 0.25 per cent. for No. 3, and C.C., 0.61; Gr.C., 2.70; Si., 1.90; Mn., 0.56; P., 1.05; and S., 0.13 per cent. for No. 4. Seventeen and eighteen tons per sq. in. were registered by Nos. 3 and 4 respectively, whilst the fracture of the former was steely and the latter dense.

Of course, castings from No. 3 mixture would be unmachinable, due to high sulphur, which influenced the combined carbon to rise to 1.85 per cent., caused probably by faulty cupola operation and condition.

Economy in steel mixtures will depend upon the price and availability of suitable steel scrap.

He thought no doubt existed that the addition of steel scrap strengthens denseness and toughens a soft, weak pig-iron; yet it should not be considered that for all practical purposes satisfactory results cannot be obtained without the addition of steel scrap. It has been shown many times that these results can be obtained with pig-iron mixtures without the use of steel scrap.

THE HISTORY OF LOAM MOULDING IN THE LIEGE DISTRICT.

DR. LONGMUIR, having thanked M. Varlet for his Paper, said he supported all the statements made therein with the exception of the statement that loam moulding was introduced in 1846. Throughout the whole of mediæval Europe and mediæval England loam moulding was in use. Prof. Turner, in his "Metallurgy of Iron," referred to the first cast-iron made in Sussex. The early Sussex ironfounders were in all probability loam moulders.

Apprenticeship Problems.

MR. GALLON (Newcastle) said in England they would be glad if they could get such boys to train as M. Varlet portrayed in his Paper, boys who would take an interest in the principles of machine construction and pattern-making, and then in moulding. They had not had such boys in this country. It would be their greatest pleasure to teach such boys all they possibly could. In England boys were put into one of the different branches of the trade, therefore they could not teach them now as M. Varlet would have them taught. He did not know a boy in the whole of England who could design a casting. He meant a young fellow who was brought into the foundry to learn the trade. He did not know one such that was taught to design a casting from the very beginning. He took notice, as he read the paper, that the men of Liege were not afraid to work. They could turn this great big slag ladle out in 18 hours. He would be glad to see it done in that time in this country. He did not know whether they worked 10 hours a day in Liege, but if they worked 8 hours it would be a very difficult thing to do the job in three days. M. Varlet described the chiselling of the centre hole out of a plate for the centre pin to work upon. He (Mr. Gallon) would like to ask if that was not a mistake. Forty-five years ago, when he was an apprentice, they used to cast those centre holes in the plate. They secured a pin vertically in the sand bed, and cast the plate around it. He considered that was very much better than boring a centre hole into the cast-iron plate. He would like to hear something as to other methods of casting cylinders. The Paper appeared to him to be a great one, and the greatness of it was its simplicity and honesty; it conveyed something they could carry away.

MR. YOUNG said he thought every foundryman attending the Conference ought to go to the Birmingham Technical School. They had not anything like it in Newcastle. He thought if other institutions went on the same lines as the Birmingham Technical School they would get the educated boy they wanted.

MR. WILKINSON congratulated M. Varlet on the excellence of his Paper and the clearness of his drawings. He (Mr. Wilkinson) totally disagreed with Mr. Gallon's remarks. It was quite possible to get young men in England to take a keen interest in their work. Personally he could recall several who came under his own charge. Showing a little aptitude for the work they were taken in hand, and they made very rapid strides. He coached one or two in the laboratory, and he was very much surprised by the interest they took in their work. He knew from personal experience that lads in the South of England, in the North and in the Midlands would take a keen interest in the work if there was the human touch to encourage them. If they tried to get at the lads on their own level a good percentage of them would try to use their brains as well as their hands. They must do a great deal more to encourage brain work among the youths in their foundries. Unless

they very carefully trained the youths to follow in their predecessors' steps and improve on their often defective work, they could not hope to hold the position they had hitherto held. It seemed to him the human side was being applied to the problem in Liege with very considerable success.

The President said M. Varlet would have an oportunity of seeing the discussion after it had been translated into French, and his reply would be published in due course.

A Written Opinion.

Mr. S. G. Smith, in a written contribution, stated that Mr. Varlet's historical notes upon the loam moulder are interesting. On column, page 473, Mr. Varlet refers to an early period of loam moulding, when the cost of production was lower by that method than in the case of the same castings made in sand, adding that to-day the contrary would be the case. Personally he did not altogether agree; so much, if not all, depends upon the way adopted, outlay, tackle, etc. There are expensive and economical ways of loam moulding.

A few years prior to the war he (Mr. Smith) produced plain repetition loam work as low as 7s. 6d; per ton, 54-in. 60-in., and 66-in. socket and spigot pipes 9 ft. 6 in. long for 10s. per ton, 40-in. and 50-in. dia. double flange Gee pipes 9 ft. 6 in. long for 12s. 6d. per ton. Internal flange cylinders 4 ft. to 8 ft. diam., and from 4 ft. to 8 ft. long, were made regularly for 20s. per ton. A medium size of the latter, three men would make one casting in two days. The above compares favourably with Mr. Varlet's figures which he gives later on in the paper.

On page 474, column 1, under the sub-heading of "Loam Mixture," the tannery waste referred to is, I assume, cow-hair?

"Sand Mixtures No. 1," consisting of new sand and horse manure, would be a rather extravagant mixture. Why not some floor sand?

On page 474, column 2, the maximum labour given for slag pan is given as 18 hours. Does this include both skilled and unskilled labour?

Page 475, Fig. No. 3, deals with a fly-wheel. He (Mr. Smith) did not think that the best method is adopted for making these wheels. Forty-five years ago we used to strike the outside of the rim up in loam, the arms were formed in dry sand cores, the rim and hub were covered with loam plates.

He had made fly and grooved rope wheels various ways, but the cleanest, quickest, and most economical way is to make and assemble the whole in dry sand cores. Such wheels, or half-wheels of any diameter or weight can be made in the minimum time and cost. A brief reference to this method and procedure appeared in The Foundry Trade Journal, May 25, 1922, in which a fly-wheel problem was dealt with.

On page 476, Fig. 4, calender cylinders are dealt with. This is a very plain external-flange cylinder. No provision appears to be made for the dross head, which he thought is necessary to obtain a clear top flange. The method adopted in making this casting involves breaking-up the brickwork for each cylinder.

If this is a repetition job it can be obviated by making suitable tackle. He (Mr. Smith) had given a full detailed description of method and procedure of making external flange cylinders without removing the brickwork, or rather, without breaking up the outside brickwork. This appeared in The Foundry Trade Journal about 1913. Mr. Varlet will find this a most economical method of producing such castings. Upwards of 50 cylinders can be made without re-bricking, or, ramming the outside of the mould.

This contribution will be unduly long if reference is made to other castings in the Paper. It is an open question regarding the superiority in skill of the loam or sand moulder. It is said that moulders, like poets are born, not made. There is little in common with the methods of the two, and a combination of both is like the old-time fitter very rare.

A loam moulder's daily routine is with spindles, plates, bricks, strickles, etc. A sand moulder's daily routine is with various kinds of patterns, boxes, rammers, etc., to which he has to apply his intelligence as well as his weight.

The risk of the sand moulder regarding faulty work is greater than the loam moulders.

THE MANUFACTURE OF LIGHT STEEL CASTINGS.

Mr. Bradley emphasised, in introducing his Paper, that he was speaking from a jobbing steel-founder's standpoint, dealing with the sand problem and pouring temperature, and with obtaining a good, sound composition. He contrasted the different requirements for repetition as distinct from jobbing work, pointing out that in the latter case it was more difficult to make good steel castings, and remarking that it was essential they should have machines for doing certain classes of repetition work.

Research on Sand Necessary.

Mr. F. Melmouth (Braintree) observed that an enormous amount of metallurgical investigation had been expended on steel production, and they had to admit that their knowledge of steel was infinitely greater than their knowledge of sand. It was a simple matter to turn out steel perfectly suitable for light castings, but it was more difficult to turn out suitable light steel castings. After the steel left the furnace it was subject to various influences of either incorrect methods of casting, speeds of casting, or incorrect sand. As to the card system, he thought it was in operation in every modern foundry, but the point he had noticed was that it appeared to be very often overdone, and in some cases the card system cost nearly as much as the casting. The runner bushes should be about the same height, so that the ladles would not have to be raised or lowered. Light steel castings as a production article were usually made in the mass production shop. With regard to the point of putting green sand castings nearer the source of the steel because they were lighter sections, in America the conviction was that light castings required drying more than the heavier type; that was, within reasonable limits. He had carried out a great deal of work on light castings, and he was rather coming round to that way of thinking. Mr. Bradley had mentioned electric welding, and there was no doubt, electric welding was considerably cheaper than acetylene welding. Had the author found out any appreciable difference in fluidity in the manufacture of steel castings by the pneumatic processes as compared with the electric furnace. He appreciated the remarks on design, and said that they would secure cheaper and better castings if the designer would consult the foundryman before he made his design.

Temperature Queries.

Mr. Darby asked what was the correct casting temperature, seeing that the speaker alluded to the difference it made in the casting. He found that he could not definitely ascertain what the correct temperature was. The reason why steel was more difficult to handle than cast-iron was because of contraction. Mr. Bradley did not give any idea of what temperature he annealed the castings, and he would like to know whether he annealed all small steel castings, because with different carbons they required different temperatures for annealing.

Mr. Wilkinson said the whole question was an extensive one, and one hardly knew where to begin to discuss it. As to the pouring temperature, there was only one, and that was the highest at which they could get the metal. He said this without any reservation whatever from long experience, and obtained castings entirely free from cracks. Cracks occurred during the setting or freezing of the metal, he said in describing an experiment in which the metal was poured at different temperatures and the mould was altered so that the casting contracted in the sand. He advised that moulds should be constructed so that contraction could properly take place. Anyone having trouble with light steel castings, he recommended that they should cast them with a small gate and make the mould so as to allow for contraction; good results would follow. In his opinion there would be no light steel castings in green sand moulds in future years. But he should not care to trust three to four tons of steel in green sand moulds. It was cheaper to make a dry sand mould than a green one, and there was the advantage of the element of safety in the dry sand mould which was entirely absent in the green sand. If it came to a question of which was the best green sand, it was possible to make sand mixtures with almost any ordinary ironfounders' sand that

would give moderately successful surfaces on green sand castings. Where most foundrymen went wrong on green sand was in making it too damp. The difficulty was to work the sand well on the dry side, yet sufficiently strong to resist the metal, but it was possible to get sand with a fair amount of bond and yet dry enough to perform its function properly.

Temperature Variations from Bottom Pouring Ladles.

Mr. Faulkner, after thanking the lecturer, remarked that in discussing the question of light steel castings they were up against a difficult proposition. With the exception of a few leading firms, they were much behind their Continental competitors. And some of the less-known metallurgical countries knew more about light steel castings than they did: indeed, he believed, the best steel castings were made in Italy, with Switzerland a good second.

With reference to the casting temperature it should be pointed out that the first drop of metal out of a bottom-pouring ladle having been in direct contact with the bottom of the ladle would be cold. The metal following would be hotter, being drawn from the body of the ladle until such time as the "time factor" began seriously to operate. The fluidity of electric steel had been adversely criticised, due, no doubt, to the fact that operators used to handling tool steel had been called upon to make steel for castings, and contrived to give to this metal the same "deadness" as that necessary for tool steel. This, the speaker affirmed, is not necessary, for, according to Dr. Desch, exceptional deadness eliminates all exothermic reactions such as one associates with steel made by the older processes.

Sand Moulds Discussed.

Mr. Harley (Coventry) remarked that he had been concerned with light steel castings in enormous quantities for the past twelve or fourteen years, ranging from 1 oz. to 3 cwt. One speaker had said no green sand steel moulds would be made, and he was not sure whether to support that or not. He had made hundreds of thousands of light steel castings, including lorry wheels, and they had cast these lorry wheels in green sand entirely and with satisfactory results; in fact, they had never had a steel lorry wheel returned. That would prove that there was not much wrong with the method of manufacture. In theory casting in green sand was the best. In his opinion a great deal of the trouble in making steel castings arose from casting them in dry sand moulds. In weights such as he had given there was, perhaps, no choice in the matter, and up to those weights he certainly should not advocate dry sand. They had sufficient to contend with in the "pulling" of mild steel, which had abnormal contraction compared with cast steel; but they intensified their difficulties by utilising hard, resistant dry-sand moulds. They must so design their patterns, and must help that by having a soft, unresisting sand mould, to allow the natural contraction to take place. If contraction took place to the full extent, then they would not have the annoying trouble of cracking. When they started on road wheels they went into this matter and they allowed too little, because the final wheels contracted more and became too small. Contraction was caused in another way; it was very essential in making any castings that the metal should not be too high in phosphorus, 0.07 per cent. being the maximum. He favoured 0.05 per cent. for both sulphur and phosphorus. Regarding pouring temperatures, it was no use attempting simply to reach a little above the melting point. The metal must be taken above the melting point by 300 deg. C., and even with that margin no time must be wasted in getting the boxes cast.

Facing Sand.

As to sand, he at one time thought he should have to send to Sheffield for special mixtures, which were, of course, fairly expensive. But he soon dropped them, because he found that within the limits of weight he had mentioned they could make perfectly good sand mixtures with ordinary red moulding sand, and mixing it up to a varying extent with ordinary floor sand and silica sand. But the basis of all sand mixtures was red sand, which he obtained from anywhere round Birmingham or Tipton. He would like to emphasise one point, that they must not try to get on facing sand the maximum refractoriness. Everybody seemed to insist in steel castings that the maximum of refractoriness was an essential condition upon being able to make a good casting surface. But his experience was that the mixture should be so regulated that it just nearly reached the point of fusion, in contact with the molten metal. If that was done, they would find the sand caked, and that the cake came off very easily and left a beautiful surface on the casting. He must state also that he did not give way to the Italians' steel castings, or those of any other Continental countries in the finish of such castings by their English converter process. He found that for every day to day work the converted process gave the most reliable results.

The Author's Reply.

Mr. Bradley, whom the President said would deal with the questions raised in writing, briefly and hurriedly replied on account of the lateness of the hour. Certainly they required the card system as a guide and a record. Generally speaking, in the repetition shop they would expect to use green sand. They all preferred electric welding where possible; it was much quicker and cheaper than the other processes. A question was asked as to oxy-acetylene being much better because it took longer to generate the heat so as not to interfere with the yield-point. But it was not the yield-point, but the cooling process which caused the hardness. Regarding fluidity in Tropenas, he considered better fluidity was obtained from them than from electric furnaces, but they could secure good fluidity from the latter, and they could shank every ounce of metal. As to annealing, they annealed all castings unless they were in a real hurry. Generally, they annealed according to the carbon; the lower the carbon the higher the temperature required. As regards casting temperature, he did not believe there was any instrument made which would record the different proper temperatures, taken from furnace to mould; he should say somewhere between the region of 1,560 to 1,660. In reference to sand, they would find at the exhibition a green sand casting 2 to 2½ in. thick which was equal in skin to a good many cast-iron castings. He disagreed that it was cheaper to make a dry-sand than a green-sand mould. A good deal depended on the class of casting and one's experience of sands. They must get the sand to withstand the metal. He must say that he had tried all up to 4 in., but had never found anything to stand up like the Yorkshire sand. Belgian was all right, but when they got up to 1 in. and over there was nothing like Yorkshire sand, from which they obtained a much better skin. Also a good deal depended on the way a man rammed his mould; this was where the skilled moulder came in. It was much more difficult to make a good green sand mould and get a good casting than a dry sand mould on that account. Referring to Mr. Harley's comment about wheels, they had made them with green sand and dry, and also with the outside chill for the outside rim, and had found the best results from green sand.

SAFETY WORK IN FOUNDRIES.

Mr. A. R. Bartlett (London) pointed out that a man who was temporarily disabled through an accident was frequently a direct loss to his employer in regard to production, because there was not only delay, but in finding a man to take his place they might not secure one so efficient or so well acquainted with the conditions of that particular job. He favoured a machine riddle for sand, and wherever possible using mechanical means and having them properly safeguarded. He suggested that employers should try to interest the men in safety measures, and it must necessarily start with the management. At the same time it was very difficult to get the men to wear goggles. Lighting and ventilating were great points in safety, but the first essential was caution.

Williams, Foster & Company, and Pascoe, Grenfell & Sons, Limited, manufacturers of copper, yellow metal and spelter, etc., of Leadenhall Buildings, E.C.3, have removed to 4, London Wall Buildings, London, E.C.2.

Some Influences of Low Temperature on the Strength and other Properties of Cast Iron.*

By A. Campion, F.I.C. (Falkirk) and J. W. Donaldson, B.Sc., A.I.C. (Greenock).

Introduction.

James Watt only succeeded in producing a working steam engine after obtaining the assistance of John Wilkinson to show him how to cast and bore the cylinders, and from that time to the present the engineer has always been largely indebted to the iron founder.

Modern engineering progress involving the use of high speeds, temperatures and pressures, together with the increase in the size of engines, has been facilitated in no small degree by the exertions of the ironfounder. The limits have not yet been reached, and it appears probable that in the immediate future the engineer will make still further demands upon the founder and metallurgist for castings of even greater complexity, and to meet more stringent specifications as regards strength and reliability.

Although cast iron is one of the most extensively employed, it is at the same time the most complex of the ferrous materials used in engineering construction, and the one least understood as regards its constitution and properties under varying conditions and treatment.

The engineer requires material which possesses considerable strength and reliability not only at ordinary temperature and pressure, but which also retains its strength, shape and size when submitted to the action of higher temperatures and pressures.

It must be frankly admitted that metallurgical progress in regard to cast iron has not kept pace with that of engineering design, but it is of the utmost importance that this deficiency be made good at the earliest possible opportunity, and that cast iron receive full and careful attention and investigation of its constitution and properties.

The future progress of engineering design and construction will largely depend upon the ability of the metallurgist to produce material capable of withstanding more severe conditions of service, and of the founder to cast it. During the last ten years the authors have given very serious and careful consideration to the manufacture, selection and testing of iron castings for use in internal combustion engines and other positions where the material is submitted to the action of high pressures, temperatures, superheated steam and other severe influences.

The object of the present paper is to set out some of the results of tests which have been made on irons of different qualities and compositions in the hope that they may prove of interest to the members, provoke a discussion from which some suggestions for further work may arise, and at the same time stimulate interest in this very important question.

Material.

Three irons have been selected from amongst a number which the authors have examined as representing widely different classes of material, and for which fairly complete sets of figures are available as regards:—(1) Change of volume after repeated heating and cooling to and from (a) 450 deg. C., (b) 550 deg. C. (2) Tensile strength after annealing for constant time at temperatures between atmospheric and 700 deg. C. (3) Tensile strength at temperatures between atmospheric and 500 deg. C.

The chemical analyses of the materials are shown in Table 1.

Table I.—*Chemical Analyses of Materials Used.*

	A1.	A2.	A3.	A4.	A5.	A6.
Total C	3.286	3.144	2.845	3.377	3.382	3.295
Gr. C.	2.716	2.334	1.950	2.647	2.662	2.599
C. C.	0.570	0.810	0.895	0.730	0.720	0.696
Si	1.745	1.840	1.447	1.560	1.237	1.716
S	0.110	0.110	0.155	0.073	0.061	0.072
P	1.541	0.868	1.036	0.950	0.751	0.766
Mn	0.195	0.510	0.490	0.510	1.080	1.660

A1 is an iron used for stove plate and other light castings.

A2 is a strong iron used for steam turbines and other marine work.

A3 is a semi-steel used with marked success for dies for tube drawing.

The first two are somewhat similar in composition so far as total carbon, silicon and sulphur are concerned, but have very different percentages of manganese and phosphorus. Although the quantity of total carbon is nearly the same in both irons there is an appreciable variation in the manner in which it exists.

In addition to the three irons referred to above there are given changes in volume, weight and tensile strength after repeated heating from 1 to 20 times, at (a) 450 deg. C. (b) 550 deg. C. and cooling of other three irons whose compositions are shown also in Table 1.

Experimental Methods.

The necessary number of bars 12 in. long and 1½in. dia. were cast from the same ladle, all at one time and under identical conditions of irons A1, A2, and A3. The bars were then rough-machined before treatment. Bars 1 in. dia. by 9 in. long were cast for irons A4, A5, A6, and machined to size before treatment.

Change of volume.—Cylindrical test pieces exactly 1 in. dia. and 6 in. long were prepared from A1, A2 and A3, and approximately 0.625 in. dia. and 5.25 in. long from A4, A5 and A6.

The specimens of the first three were placed in an electrically-heated furnace with closed ends and through which a current of coal-gas passed. The test pieces were gradually raised to the desired temperature, maintained at it for 7 hours and then allowed to cool in the furnace. The dimensions of the bars were measured after each five heatings by means of a vernier reading to a ten-thousandth of an inch.

The A4, A5 and A6 bars were heated for 6 hr. periods without the coal-gas passing through the furnace, being simply bedded in asbestos wool. The dimensions in these experiments were taken by means of micrometer calipers reading to ten-thousandths of an inch.

The temperatures of heating (450 deg. C. and 550 deg. C.) were chosen because the experiments were originally made to determine the most suitable material to use in the liner and piston of a type of internal combustion engine in which the average temperature of the metal had been found to be between 400 deg. C. and 500 deg. C. All further experiments have been made at the same temperatures for comparison purposes. The fact that the results of the tests were found to agree very closely with those obtained in actual practice indicates that the temperatures were well chosen.

Some results are also given for irons A4, A5 and A6 heated to 550 deg. C. after having been previously submitted to 21 treatments at 450 deg. C. and cooled in air. These results are of interest inasmuch as they give an indication of the possible effect of occasional overheating, such as might occur in the event of the cooling medium running short or circulation interrupted.

Annealing.—The test bars, 6 in. long, rough-turned and screwed, 1⅛ in. Whitworth thread at the ends, were placed in an electric muffle-furnace, maintained at the desired temperature for 4 hrs. and then allowed to cool in the furnace, precautions being taken to reduce oxidation to a minimum in all experiments. The bars were then machined to exactly ½ sq. in. area in the parallel portion.

Strength at High Temperatures.—The test pieces were of the same dimensions as those employed in the annealing experiments. They were screwed into the sockets of long holders, and surrounded by an electrically heated furnace which was attached to the machine. The holders themselves were surrounded for a considerable distance by the furnace in order to ensure thorough and uniform heating of the test pieces. Thermo-couples were clamped to the test pieces, so that the actual temperature of the metal and not of the furnace was determined. The bars were

* A Paper read before the Birmingham Conference of The Institute of British Foundrymen.

slowly heated to the desired temperature and when it had become constant, was maintained for half an hour and then tested. Special precautions were taken to ensure that the rate of loading of the specimens was the same in all cases, and as a further check an autographic record was taken of every test.

Each of the materials was tested in the condition as cast and also after having been annealed, by heating to 400 deg. C for 4 hrs. and allowed to cool in the furnace, in order to remove strains due to casting or machining.

Strength after Repeated Heating and Cooling.

The growth test bars of irons A1, A2 and A3 after treatment were prepared and tested for tensile strength. Materials A4, A5 and A6 were tested more fully as the necessary number of previously machined test pieces were treated and tested after each treatment. 10 sets of bars were placed in the furnace, and one set taken out after each of the first 6 heatings and one each after the 9th, 15th, and 20th heating and then tested. The test pieces were 8 in. long by ½ sq. in. area in the parallel portion and screwed ⅜th. Whitworth thread at the ends.

Consideration of Experimental Results.

The average results of all the experiments are given in Tables 2 to 12 and graphically in Figs. 1 to 6.

Changes in Volume Consequent upon Repeated Heating and Cooling.—A1 shows by far the largest

TABLE II.—*Change of Volume After Repeated Heating to 450 deg. C. and Cooling.*

Condition.	A1. Volume cub. in.	A1. Change %	A2. Volume cub. in.	A2. Change %	A3. Volume cub. in.	A3. Change %
Original	4.7124		4.7124		4.7124	
After 5 heatings	4.7162	+0.0806	4.7156	+0.0679	4.7147	+0.0488
,, 10 ,,	4.7184	+0.1274	4.7178	+0.1145	4.7167	+0.0912
,, 15 ,,	4.7176	+0.1103	4.7261	+0.2907	4.7197	+0.1549
,, 20 ,,	4.7170	+0.0976	4.7263	+0.2949	4.7187	+0.1359
,, 25 ,,	4.7171	+0.0995	4.7263	+0.2949	4.7187	+0.1359

TABLE III.—*Change of Volume after Repeated Heating to 550 deg. C. and Cooling.*

Condition.	A1. Volume cub. in	A1. Change %	A2. Volume cub. in.	A2. Change %	A3. Volume cub. in.	A3. Change %
Original ..	4.7124		4.7124		4.7124	
After 5 heatings	4.7273	+0.3160	4.7193	+0.1460	4.7176	+0.1103
,, 10 ,,	4.7396	+0.5770	4.7196	+0.1530	4.7227	+0.2185
,, 15 ,,	4.7556	+0.9170	4.7202	+0.1660	4.7227	+0.2185
,, 20 ,,	4.7692	+1.2050	4.7205	+0.1740	4.7227	+0.2185
,, 25 ,,	4.7892	+1.6290	4.7205	+0.1720	4.7227	+0.2185
,, 30 ,,	4.8006	+1.8720	4.7205	+0.1720	4.7227	+0.2185
,, 35 ,,	4.8183	+2.2480	—		—	
,, 40 ,,	4.8309	+2.5140	—		—	
,, 45 ,,	4.8437	+2.7860	—		—	
,, 50 ,,	4.8479	+2.8750	—		—	
,, 55 ,,	4.8531	+2.9860	—		—	

TABLE IV.—*Change of Volume After Repeated Heating to 450 deg. C. and Cooling.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
Original ..	1.6118		1.6900		1.6972	
After 1 heating	1.6146	+0.170	1.6921	+0.006	1.6995	+0.130
,, 2 heatings	1.6193	+0.460	1.6944	+0.260	1.7017	+0.260
,, 3 ,,	1.6195	+0.480	1.6919	+0.112	1.7012	+0.230
,, 4 ,,	1.6130	+0.070	1.6890	—0.059	1.6983	+0.060
,, 5 ,,	1.6124	+0.040	1.6890	—0.059	1.6978	+0.090
,, 6 ,,	1.6119	+0.010	1.6878	—0.030	1.6967	—0.030
,, 9 ,,	1.6149	+0.190	1.6897	—0.017	1.6967	—0.030
,, 12 ,,	1.6164	+0.280	1.6897	—0.017	1.6961	—0.060
,, 15 ,,	1.6137	+0.120	1.6864	—0.213	1.6931	—0.240
,, 18 ,,	1.6134	+0.100	1.6864	—0.213	1.6928	—0.260
,, 20 ,,	1.6134	+0.100	1.6864	—0.213	1.6928	—0.260

TABLE V.—*Change of Volume After Repeated Heating to 550 deg. C. and Cooling.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
Original ..	1.7642		1.6967		1.7754	
After 1 heating	1.7577	—0.362	1.6834	—0.783	1.7681	—0.411
,, 2 heatings	1.7568	—0.413	1.6844	—0.724	1.7666	—0.495
,, 3 ,,	1.7637	—0.002	1.6887	—0.471	1.7672	—0.461
,, 4 ,,	1.7653	+0.068	1.6892	—0.442	1.7675	—0.444
,, 5 ,,	1.7662	—0.119	1.6925	—0.247	1.7693	—0.343
,, 6 ,,	1.7667	+0.147	1.6928	—0.229	1.7686	—0.383
,, 9 ,,	1.7670	+0.164	1.6931	—0.212	1.7681	—0.383
,, 12 ,,	1.7679	+0.215	1.6920	—0.277	1.7681	—0.383
,, 15 ,,	1.7682	+0.232	1.6914	—0.312	1.7681	—0.383
,, 18 ,,	1.7679	+0.215	1.6914	—0.312	1.7681	—0.383
,, 20 ,,	1.7679	+0.215	1.6914	—0.312	1.7681	—0.383

TABLE VI.—*Change of Volume After Repeated Heating to 550 deg. C. and Cooling After Previous Treatment at 450 deg. C.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
After 20 heatings at 450 deg. C.	1.5430	—	1.6864	—	1.6927	—
After 1 heating	1.5430	—	1.6836	—0.166	1.6930	+0.018
,, 2 heatings	1.5450	+0.129	1.6866	+0.012	1.6944	+0.100
,, 3 ,,	1.5460	+0.194	1.6905	+0.243	1.6956	+0.171
,, 4 ,,	1.5470	+0.259	1.6916	+0.308	1.6970	+0.254
,, 5 ,,	1.5460	+0.194	1.6930	+0.391	1.6959	+0.248
,, 6 ,,	1.5470	+0.259	1.689	+0.195	1.6944	+0.100
,, 9 ,,	1.5480	+0.324	1.6897	+0.195	1.6944	+0.100
,, 12 ,,	1.5480	+0.324	1.6908	+0.261	1.6944	+0.100
,, 15 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100
,, 18 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100
,, 20 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100

TABLE VII.—*Changes of Weight After Repeated Heating at 450 deg C. and Cooling.*

Condition.	A4. Weight Grams	A4. Change %	A5. Weight Grams	A5. Change %	A6. Weight Grams	A6. Change %
Original ..	189.220	—	198.690	—	199.320	—
After 1 heating	189.220	—	198.690	—	199.320	—
,, 2 heatings	189.225	+0.022	198.695	+0.002	199.320	—
,, 3 ,,	189.242	+0.011	198.705	+0.007	199.340	+0.010
,, 4 ,,	189.240	+0.011	198.715	+0.012	199.340	+0.010
,, 5 ,,	189.240	+0.011	198.715	+0.012	199.340	+0.010
,, 6 ,,	189.245	+0.013	198.715	+0.012	199.345	+0.012
,, 9 ,,	189.295	+0.039	198.790	+0.050	199.390	+0.035
,, 12 ,,	189.310	+0.047	198.812	+0.061	199.410	+0.045
,, 15 ,,	189.320	+0.053	198.815	+0.063	199.420	+0.050
,, 18 ,,	189.340	+0.063	198.820	+0.066	199.435	+0.057
,, 20 ,,	189.355	+0.071	198.835	+0.073	199.450	+0.065

TABLE VIII.—*Changes of Weight After Repeated Heating to 550 deg. C. and Cooling.*

Condition.	A4. Weight Grams	A4. Change %	A5. Weight Grams	A5. Change %	A6. Weight Grams	A6. Change %
Original ..	207.130	—	199.490	—	208.390	—
After 1 heating	207.160	+0.014	199.510	+0.010	208.400	+0.004
,, 2 heatings	207.180	+0.028	199.530	+0.020	208.420	+0.014
,, 3 ,,	207.230	+0.048	199.590	+0.050	208.470	+0.038
,, 4 ,,	207.250	+0.057	199.600	+0.055	208.490	+0.047
,, 5 ,,	207.260	+0.062	199.605	+0.057	208.500	+0.052
,, 6 ,,	207.260	+0.062	199.610	+0.060	208.500	+0.052
,, 9 ,,	207.290	+0.077	199.635	+0.072	208.520	+0.062
,, 12 ,,	207.310	+0.086	199.650	+0.080	208.550	+0.076
,, 15 ,,	207.310	+0.086	199.655	+0.082	208.550	+0.076
,, 18 ,,	207.330	+0.096	199.665	+0.087	208.570	+0.086
,, 20 ,,	207.350	+0.106	199.680	+0.095	208.590	+0.096

TABLE IX.—*Showing the Effect of Annealing at Various Temperatures.*

Temperature, deg. C.	A1. Tons per sq. in.	A1. Change %	A2. Tons per sq. in.	A2. Change %	A3. Tons per sq. in.	A3. Change %
15	10.20	—	15.00	—	16.60	—
100 ..	10.50	+ 2.94	15.05	+ 0.33	16.45	— 0.903
200 ..	10.45	+ 2.45	15.10	+ 0.66	16.50	— 0.603
300 ..	10.85	+ 6.37	14.84	— 1.06	16.20	— 2.400
400 ..	11.00	+ 7.84	14.40	— 4.00	16.80	+ 1.204
500 ..	10.70	+ 4.90	14.10	— 6.00	15.90	— 4.216
600 ..	9.55	— 6.37	13.20	— 12.60	14.90	— 10.240
700 ..	8.20	— 19.61	11.84	— 21.06	13.40	— 19.270

TABLE X.—*Strength at Elevated Temperatures in Cast and Annealed Condition.*

Temperature	A1. Tons per sq. in. As cast.	A1. Annealed.	A2. Tons per sq. in. As cast.	A2. Annealed.	A3. Tons per sq. in. As cast.	A3. Annealed.
15	10.15	11.00	15.00	15.00	16.60	16.80
100	9.90	11.00	14.92	15.17	16.40	16.80
200	9.70	11.50	14.40	14.80	16.05	16.90
250	—	—	13.90	—	15.65	—
300	10.15	11.25	13.30	14.90	15.90	16.90
350	—	—	14.00	—	—	—
400	10.20	11.30	14.80	15.08	16.95	16.90
500	10.05	11.00	13.95	14.40	15.90	15.84
600	7.30	8.10	12.80	—	—	—
700	3.35	4.00	6.40	—	—	—
800	—	—	2.70	—	—	—

variations when heated in a non-oxidising atmosphere of any of the materials considered in the present paper. The results of the 450 deg. C. heatings are erratic and exhibit no tendency to change in any particular direction. The maximum growth is found after 10 heatings, when the volume decreases until after 20 heatings where a slight increase is again registered, but it appears that this material never attains a constant volume. Heating to 550 deg. C. causes a continued growth and even after 55 treatments there is no indication that constancy will obtain. It is evident that this material is most unsuitable for use in positions where permanency of size or shape is required, especially if, as is so often the case, the material is subject to oxidising influences. The effect of the treatment is to reduce seriously the strength of the iron.

A2 shows a maximum percentage of growth at 450 deg. C. which is in excess of that of A1 after 20 heatings, but the volume has then become permanent. The maximum growth of this sample at 550 deg. C. is also attained after 20 heatings, but is less in amount than shown by the same material at the lower temperature, and in this respect it differs from the other irons with which the authors have so far experimented, for they have all shown a greater increase at 550 deg. C. than at 450 deg. C. This iron shrinks a little between 20 and 25 heatings, but then remains constant. The effect of the repeated heating is to reduce very considerably the strength, although in a less degree than A1.

A3 shows a much smaller percentage of change than either A1 or A2 at 450 deg. C. The maximum increase is reached after 15 heatings, which is followed by a reduction until 20 heatings when permanency of size is attained. Heating this material 10 times at 550 deg. C. produces an increase of volume greater than the maximum obtained under 450 deg. C. treatment, but it shows no further change even after 30 heatings. It would appear from these results that semi-steel is a more suitable material to employ when alteration of size or shape is to be avoided than ordinary cast iron, as the casting could be heated and cooled a few times before being put into service and, further, the strength is comparatively little affected by the treatment.

A4 reaches its maximum size at the third heating, then steadily contracts until the sixth, increasing again to the 12th, and then shows no further change. The total amount of growth is greater than that of either of the first three irons with the exception of A1 at 550 deg. C. Although the effect of treatment at 550 deg. C. is to cause a quicker attainment of constant size the amount of the increase is greater than that at the lower temperature, and curiously enough the first three heatings produce a diminution instead of an increase of volume. The effect of treatment at 550 deg. C. on the material after it has been heated 20 times at 450 deg. C. is a steady increase of size for nine heatings, when no further change takes place.

Heating A5 at 450 deg. C. at first causes an increase of volume reaching its maximum at the 2nd treatment, but between 3rd and 15th a steady diminution of volume results, when at the latter constancy is obtained. Heating this material at 550 deg. C. causes a contraction to take place, which diminishes to the 9th, then increases slightly to 15th, after which no further change takes place. Heating this material to 550 deg. C., after previously being submitted to 20 treatments at 450 deg. C., causes a steady increase in volume for the first 12 heatings and shows no further change after a slight decrease at 15th.

Heating A6 at 450 deg. C. causes it to behave in a very similar manner to A5, although contraction of volume begins a little later, and the ultimate reduction of size is slightly greater than that of either A4 or A5. Heating to 550 deg. C. causes a contraction in volume after the first four heatings, but no further change occurs as a result of subsequent treatment. Heating to 550 deg. C. after previous treatment at 450 deg. C. produces a growth which reaches its maximum at the 4th; between the 5th and 6th heatings there occurs a considerable reduction in volume, but further heatings produce no change. It is to be noted that this iron retains its strength after repeated heating and cooling better than any other which the authors have mentioned in this Paper; in fact, the strength is actually greater to the extent of 3.21 per cent. after the 450 deg. C. treatment than the original, while the 550 deg. treatment has resulted in an increase of 3.44 per cent. on the strength of the original iron.

The satisfactory behaviour of this iron the authors consider to be mainly due to the high manganese and moderate phosphorus content. It is of interest to note that irons A4, A5, A6 are very much alike in composition except for the manganese, and that the loss of strength is less as the manganese increases.

Table XI.—*Change of Strength After Repeated Heating and Cooling.*

Condition.	450°C.						550°C.					
	A4.		A5.		A6.		A4.		A5.		A6.	
	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.
Original	12.96	—	13.36	—	14.73	—	12.96	—	13.36	—	14.73	—
After 1 heatings ..	12.96	—	13.87	+ 3.817	14.31	— 2.851	12.49	— 3.626	13.33	— 0.224	14.09	— 4.344
„ 2 „ ..	12.34	— 4.780	13.58	+ 1.646	14.72	— 0.067	12.74	— 1.690	13.38	— 0.149	14.11	— 4.209
„ 3 „ ..	12.83	— 1.003	13.51	+ 1.122	14.46	— 1.833	12.59	— 2.855	13.41	+ 0.374	14.49	— 1.629
„ 4 „ ..	12.82	— 1.080	13.52	+ 1.197	14.32	— 2.873	12.45	— 3.935	13.65	+ 2.170	14.48	— 1.697
„ 5 „ ..	12.25	— 5.470	13.55	+ 1.422	14.84	+ 0.746	12.65	— 2.392	13.67	+ 2.320	14.64	— 0.611
„ 6 „ ..	12.69	— 2.083	13.31	— 0.374	14.91	+ 1.222	12.04	— 7.098	13.48	+ 0.898	14.63	— 0.678
„ 9 „ ..	11.90	— 8.178	13.15	— 1.571	14.98	+ 1.697	10.83	—16.430	13.41	+ 0.374	14.80	+ 0.475
„ 15 „ ..	10.72	—17.280	13.12	— 1.795	15.03	+ 2.036	9.32	—28.081	13.36	—	14.93	+ 1.357
„ 20 „ ..	10.52	—18.820	13.22	— 1.020	15.20	+ 3.210	7.25	—44.060	13.41	— 1.690	15.24	+ 3.440

Table XII.—*Change of Strength After Repeated Heating and Cooling*

Condition	A1.		A2.		A3.	
	Tons per sq. in.	Change %	Tons per sq. in.	Change %	Tons per sq. in.	Change %
Original ..	10.20	—	15.00	—	16.60	—
After 25 heatings at 450 deg. C.	9.72	— 4.70	13.50	—10.00	14.85	10.54
After 25 heatings at 550 deg. C.	—	—	13.00	—13.30	13.99	15.70
After 55 heatings at 550 deg. C.	7.50	—26.47	—	—	—	—

Changes of Weight Consequent upon Repeated Heating and Cooling.

The determinations were made only on the last three irons whose analyses are given in Table I., and the results, which call for little comment, are given in Tables VII. and VIII. It will be observed that in all cases there is a steady and fairly regular increase after each heating. At 450 deg. C. A6 shows a rather smaller total increase than A4 or A5, whilst at 550 deg. C. A4 gains rather more than A5 and A6.

Annealing.—The results of these experiments are shown in Table IX. The principal features are the very pronounced weakening which results from annealing at temperatures above 400 deg. C. It has previously been shown by Longmuir and Hatfield that annealing grey cast irons at high temperature destroys the strength. The other feature is the maximum strength which the materials attain at a temperature between 200 deg. C. and 400 deg. C., and which varies with different irons. The loss of strength at 700 deg. C., the highest temperature employed in these experiments, is practically of the same order for all materials.

A1 increases up to 400 deg. C., when it is 7.84 per cent. stronger than the untreated material, at 500 deg. C. a reduction occurs and continues to 700 deg. C., when the strength is reduced by 19.6 per cent.

A2 increases slightly when treated at temperatures up to 200 to 250 deg. C., after which there is a steady fall to 21.06 per cent. below the original at 700 deg. C.

A3 shows a loss of strength at all temperatures up to 300 deg. C., then it increases to 1.204 per cent. above the untreated at 400 deg. C., afterwards decreasing until at 700 deg. C. the strength is 19.27 per cent. less than the orginal material.

These results are somewhat difficult to explain at present. It is conceivable that the release of internal stress might cause a certain amount of increase in the strength, but the fluctuation between minima and maxima points seems to require some further explanation. The authors have examined a number of annealed irons microscopically, but it would make the paper too long to include the results of their work in this direction, so that they prefer to reserve that part of the investigation for another occasion and after they have more fully studied the subject. It appears, however, that the arrangement and dis-

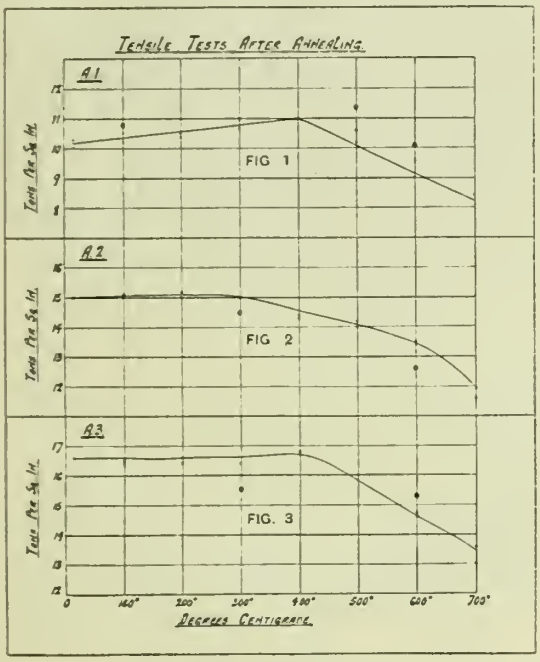
tribution of the graphite, carbides and phosphides plays a very prominent part, as does also the contignity of these constituents.

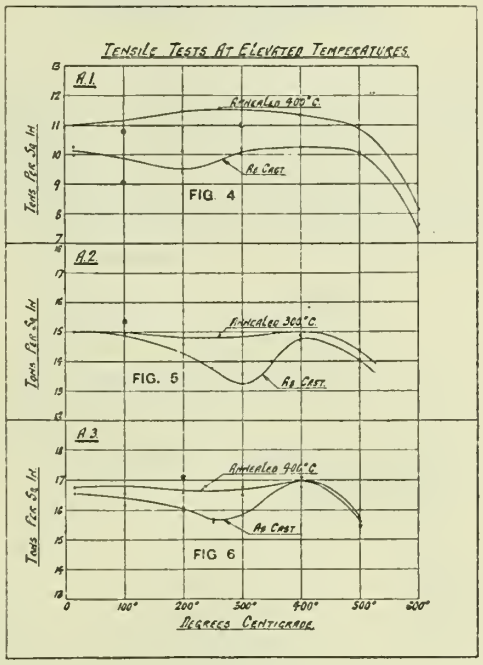
Strength at Elevated Temperatures.

The means of the results on the material "As cast," and also after annealing, are shown in Table X. and graphically in Figs. 4, 5 and 6.

Very few results of high temperature tests of cast iron have so far been published, and the majority of these are not in agreement with those obtained by the present authors, or with some unpublished results of other investigators of which they have knowledge.

Tests on Material in Natural Condition.—The most striking feature about these results is the well-defined maxima and minima points exhibited by all materials, and which occur at nearly the same temperature for each of the materials. A1 exhibits a minimum at 200 deg. C. which is, although well marked, less pronounced than in the case of A2 and A3. The maximum at 400 deg. C. is not well marked although distinct, and the strength at this point is approximately ¼ per cent. greater than that of the original material tested at 15 deg. C. At temperatures above 500 deg. C. A1, A2 and A3 all lose strength somewhat rapidly, A1 has a strength of only 3.35 tons per sq. in. at 700 deg. C. or 67 per cent. reduction.





A2 is at minimum strength at 300 deg. C. and maximum at 400 deg. C., both points being much more pronounced than in the case of A1. The strength falls away continuously from 15 to 300 deg. C. where the reduction amounts to 11.3 per cent., rises to 400 deg., where the strength is about the same as at 15 deg., and falls away again to 500 deg. to 7.0 per cent. below the original.

A3 behaves similarly to A2, giving its highest strength at 400 deg. with an increase of 2.1 per cent. The minimum, which is 5.95 per cent. below the 15 deg. result, occurs at 250 deg. C., after which it increases to 400 deg. C. and then quickly falls away to 15.9 tons per sq. in., representing a reduction of 4.22 per cent. at 500 deg. C.

Tests of Material Previously Annealed.—The results generally are of the same type as obtained with the material in the untreated condition, but the variations of strength are smaller. The effect of the annealing has been to give greater regularity, and it will be noticed that the curves in Figs. 4, 5 and 6 are smoother, but the dip between 250 and 300 deg. C. is still evident in A2 and A3.

A1 gives a totally different result after annealing than the "as cast" material; the maximum strength is obtained at 200 deg. C., the point at which the minimum is given by the untreated iron, and further there appears no marked rise or fall below 500 deg. C.

The Authors are at present unable to offer an adequate explanation of these phenomena but are carrying out at present some investigations, the results of which they hope may shed some light on this intricate but exceedingly interesting and important problem. They have reason to think that the distribution of the graphite and phosphide eutectic is largely responsible, as well as the nature and amount of the gases occluded and dissolved in the iron.

Strength after Repeated Heating and Cooling.

The details of the tests of the six materials after repeated heating at 450 deg. and 550 deg. C. are shown in Tables XI. and XII. A1 and A2 both suffer a considerable reduction of strength as a result of the treatment as also does A4. It is somewhat curious that after 25 heatings at 450 deg. C., A2 shows a percentage loss of strength of about double that lost by A1 under similar treatment, but when the temperature of heating is 550 deg. C. the position is reversed.

A4 shows a very great loss of strength at both temperatures, especially after the sixth heating.

A5 retains its strength to a very large degree at both temperatures, the percentage reduction being only 1.02 and 1.69 after 20 heatings at 450 deg. and 550 deg. respectively.

A6 behaves differently from any of the others, inasmuch as it actually appreciates in strength at both temperatures, a fact that has already been noted in an earlier section of this Paper.

The irons dealt with in this Paper all contain the normal proportion of total carbon as they were not made from any specially selected brand of iron, the object being to obtain information as to the behaviour of castings made from ordinary everyday material, with or without special additions or treatment. Total carbon is a most important factor in determining the behaviour of iron under repeated heating and cooling however the heating may be applied, and from information in their possession the Authors are confident that had the total carbon in A6 been under 3.00 per cent. it would have given still better results as regards growth and strength after repeated heating and at elevated temperatures. They are aware that in some quarters the use of manganiferous cast iron is objected to for reasons which it is difficult to understand, but it is their experience that such material gives results, in practice, much superior to that which contains low manganese. A6 is an iron which can be quite easily machined at a good speed and gives good surfaces both as regards appearance and wearing properties.

The investigations are being continued, and it is hoped to publish very shortly further results upon other materials of the cast-iron type. Semi-steel appears to offer at least a partial solution to the problem of providing a material capable of being easily cast, which will retain a greater proportion of its strength at atmospheric temperature when submitted to the action of more elevated temperatures. The authors are experimenting

with such material not only in its ordinary form, but also containing certain proportions of special constituents, and prepared under different conditions. The question of heat treatment of cast iron and semi-steel is also receiving their attention.

In the present Paper the authors have purposely given only the results of tests as they have been obtained and refrained from propounding any theory to explain the various phenomena, firstly because their main object was to show how irons of widely different qualities were affected by various heat influences and secondly because the theoretical aspect of the question is of so much importance that they deemed it better to reserve it for another occasion when it could receive more detailed attention.

The authors desire to acknowledge their indebtedness to all those who have assisted them by providing material and in other ways. To Mr. J. Cameron, of Kirkintilloch, for providing the semi-steel and for the great interest he has shown in the experiments.

They also desire to thank the directors of Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, in whose works and laboratories a considerable part of the experimental work was carried out, for permission to make use of the data so obtained.

Systematic Gating.

By W. Pyatt.

All foundries have scrap castings, but whatever the percentage may be, it is generally attributed to various causes which in many cases are wrong ones. In many foundries there is a much larger percentage of scrap castings through faulty gating than most foundrymen realise, owing chiefly to the fact that the action of the inflow of molten metal cannot be seen. The defects caused through incorrect gating are so varied that they are consequently classified incorrectly. In many cases these are attributed to sulphur, phosphorus, damp moulds, etc. Such defects can be eliminated by a system of gating instead of allowing the moulder to search the foundry for gates which he thinks will answer, and which very often are unsuitable, but it escapes the foreman's notice until casting time. Additionally they may be in the wrong position, with scabs, blow holes, etc., as a result. A system can be adopted in any foundry where repeat orders from same pattern are expected, even with small alterations. A partitioned rack should be provided in foundry pattern stores, and the pattern number plainly marked on each box. Having carefully determined the required area of gate according to size and design of casting, these gates should then be made of good hard wood and plainly marked with pattern number to correspond with racks. Additionally, the position of the gate or gates should be marked on the pattern with a distinctive colour. Having adopted a system it is imperative that gates are replaced in their respective racks when not in use.

The advantages of systematic gating may be exemplified by a planing machine table of any dimension. The usual practice is to cast face-down on a levelled bed.

Instead of being level it is preferable to incline the surface 1 in. in 5 ft., and to fix gates to enter in volume at the bottom, as shown in Fig. 1. The metal will then roll quietly up hill. No venting is required, for the pressure of metal will force down the gases, providing a good open sand is used, especially if skin dried. A similar system can be applied to such castings as lathe beds.

On account of the accumulation of dirt on flowing metal, it is sometimes policy, where parts have to be machined, to gate on the top of the mould in order to ensure a clean casting below the head, as in such castings as marine cylinders and rams. The author's system of gating marine cylinders weighing up to 10 tons each, was to cast the bore vertically, the mould being made by striking in loam, and built up with plates and cinders. The back of the top plate was constructed so as to form a pouring basin. The circular hole in top plate is to allow centre core to pass through. This was made $\frac{1}{2}$ in. larger in dia. than the main core. After striking a flat surface, it is dried and turned over, the pouring basin is bricked up and loamed, the whole being thoroughly dried. The main core is made 18 in. longer than casting, and when in position and top plate lowered over the projecting main core, there remains $\frac{1}{4}$ in. clearance between the centre hole in the plate and the main core. This is shown in Fig. 2. This $\frac{1}{4}$ in. clearance is used as the gate, and in a 10-ton casting it is necessary to check the flow by fixing cast-iron wedges in the clearance every 6 in. By this method of gating a continuous stream of metal is obtained all round the core which ensures a clean bore.

The system applies to-day in one foundry for all cylindrical castings with good results.

Where a system applies to one class of casting it is worth while trying for others, but it must be strictly enforced once started. The result will be saving in moulders' and pattern-makers' time and material and the reduction of a large percentage of scrap castings.

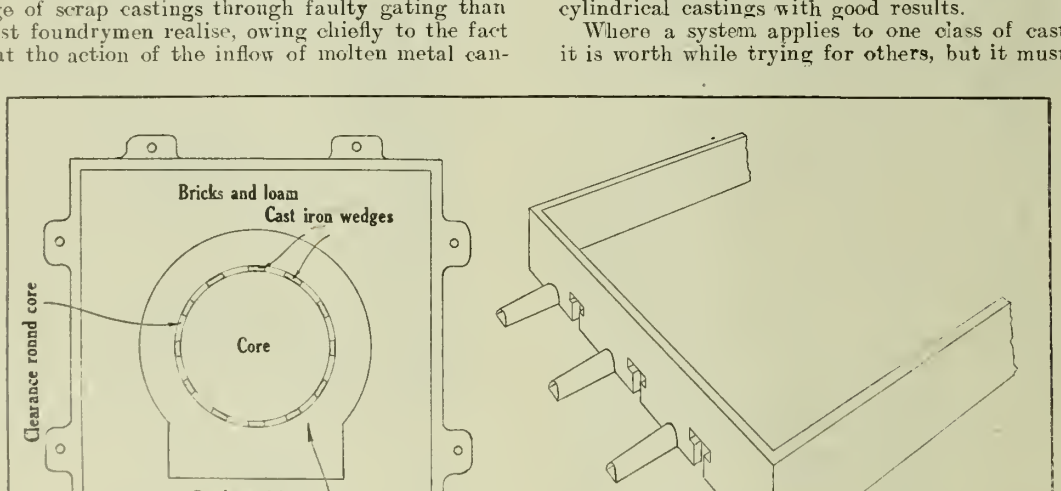


FIG. 2
Pouring basin and channel

FIG. 1

The Lofthouse Engineering Company, Limited, is being wound up voluntarily, with Mr. H. F. Wareham, the chairman, as liquidator.

Mr. W. H. Brittain, of Storth Oaks, Ranmoor, died on June 29 at the age of 87 years. The deceased gentleman, on leaving school, was apprenticed to Messrs. Standfield, Newbould & Baildon, merchants and cutlery manufacturers, Sussex Works, Sheffield. Mr. Charles Hall carried on business at the Alma Works as file, steel, and edge tool manufacturer, under the style of "William Hall," a firm which was established in the previous century. Mr. W. H. Brittain joined Mr. Hall in partnership, and from 1860 to 1866 travelled over the Continent in the interests of the house with which he was associated. Later the business was amalgamated with Messrs. Sanderson Bros. and Newbould. At the end of 1866 Mr. Hall retired from the firm, and Mr. W. H. Brittain took charge of the works of which he was principal up to the time of his death.

Institution of British Foundrymen.

LANCASHIRE BRANCH.
General Meeting.

A meeting of the Lancashire Branch was held on Saturday, May 6, at the Manchester College of Technology. At the opening of the proceedings Mr. W. H. Meadowcroft, the retiring branch president, occupied the chair.

Secretary's Report.

The report of the hon. secretary, Mr. J. Hogg, congratulated the members on the present state of the branch and the excellent work which had been done during the year. A varied list of lectures was prepared by the council, and all the engagements were fulfilled. The annual dinner, held on January 14, was a very enjoyable and successful event. The membership now comprised 90 members, 149 associate members, 5 associates, and 5 subscribing firms, a total of 249. These figures included the Burnley section, with 21 members and 24 associate members. Ten council meetings had been held, and were very well attended. Owing to the unfortunate dispute in the coal industry no visits to works were arranged during last summer, but it was intended to resume them, and arrangements would be made for visits to the blast furnaces at Staveley and the Keighley laboratories. Expenditure has been rather more than usual. Postage of circulars now costs 21s. monthly, as compared with 10s. 6d. before, and there had been expenses connected with the opening of the Burnley section. The balance in hand from December, 1920, was £8 11s. 4d.; on December 31, 1921, it was £6 8s. 2d. During the year one of the members of the Lancashire branch, Mr. Oliver Stubbs, had been the president of the institution. Other interesting features of the year were the annual conference of the institution at Blackpool and the fact that the Royal Charter had now been granted fully.

The report and balance-sheet were adopted and a vote of thanks to the retiring officers was passed unanimously. In replying, Mr. Meadowcroft said he was glad to have had the opportunity of assisting with the work of the institution as a branch president, and he would continue to do so in another capacity. All who were concerned with foundries knew that there was much to be done, and the institution was laying the foundation for a great and permanent improvement.

Mr. Hogg observed that one reason for his resignation was that he was convinced they had a reserve of members who, given the opportunity, would show that they were quite competent to carry the branch on successfully. The post of secretary was a very honourable one, and he desired to thank the members for having made it an exceedingly pleasant one for him.

Election of Officers.

The election of officers resulted as follows:—Branch president, Mr. J. Haigh; senior vice-president, Mr. R. A. Miles. These were unopposed. For the office of junior vice-president two names were submitted, and Mr. J. Masters was elected. There were three candidates for the post of secretary, vacated by Mr. Hogg, and Mr. T. Makemson was elected by a large majority of the total votes. Seven nominations were made for representatives to the General Council, and the ballot decided in favour of Messrs. Hogg, Meadowcroft, and Miles, with Mr. Jolley and Mr. H. Sherburn for the fourth place. Both gentlemen expressed a desire to retire in favour of the other, and eventually Mr. Jolley was selected. Nine members of the branch council were required and twelve names were submittd to the ballot, the three who received the most votes to serve for three years, the next three for two years, and the remaining three for one year. The result of the ballot was that Messrs. Jolley, Baron, and Hill were elected for three years, Messrs. Cook, Pell, and Sutcliffe for two years, Messrs. Swift, Greenwood, and Baron for one year. Messrs. R. P. Layfield and J. Nicholls were appointed auditors unopposed.

Manganese Ore in Hungary.—Some deposits of manganese ore are being opened up in the County of Veszprém, in Hungary, and a company has been formed under the auspices of the Deutsche Bank to exploit the orefield.

Three Months' Variations in Prices

The accompanying curves show the price variations during the three months ended June 30 in pig-iron, semi-finished and finished iron and steel, coke, and rubio ore delivered Middlesbrough, together with variations in tin, copper, lead and spelter. Prices of pig-iron have remained practically unchanged, with the exception of No. 3 Scotch, which has shown a

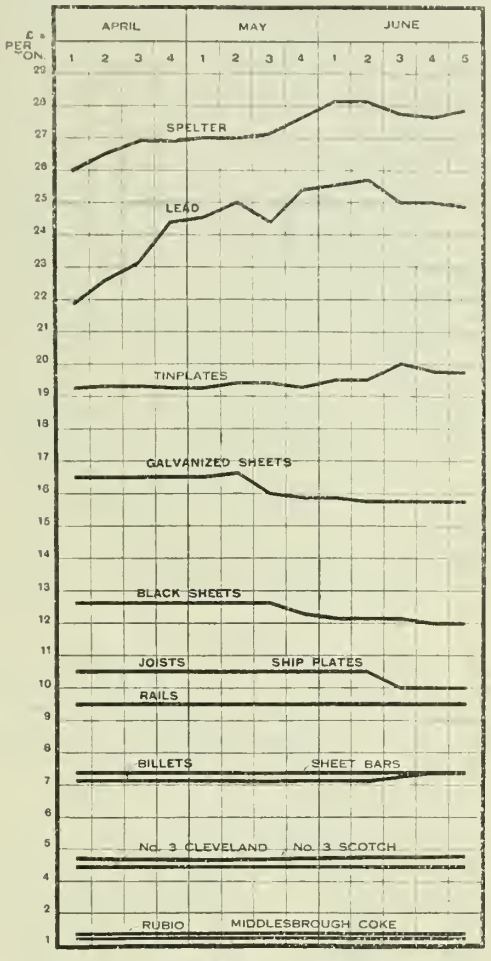


FIG. 1.—THREE MONTHS' VARIATIONS IN PRICES OF ORE, IRON AND STEEL, LEAD AND SPELTER.

slight upward tendency. Billets and sheet bars, which at the end of last quarter, on the Association price basis, differed by about 12s. 6d. per ton, are now the same price at about £7 7s. 6d. per ton. In the first quarter, the Association price was being undersold outside the area by about 15s. per ton,

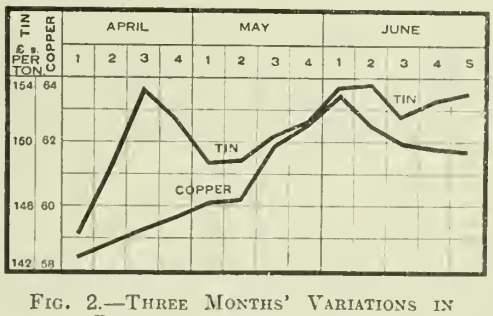


FIG. 2.—THREE MONTHS' VARIATIONS IN PRICES OF TIN AND COPPER.

whilst at the present time the Association price is several shillings higher than outside quotations.

The prices of tin, spelter and lead have shown an upward tendency during the past quarter, whilst the price of copper, after a rise from about £59 to about £62 at the beginning of June, showed a progressive decline up to the end of the month.

THE partnership heretofore subsisting between Messrs. F. J. Owen, A. G. Owen, T. H. Owen and W. P. Owen, iron, steel and general merchants, 3 and 4, Chapel Chambers, Castle Street, Swansea, under the style of Owen Brothers, has been dissolved.

Moulding Barrel Castings.

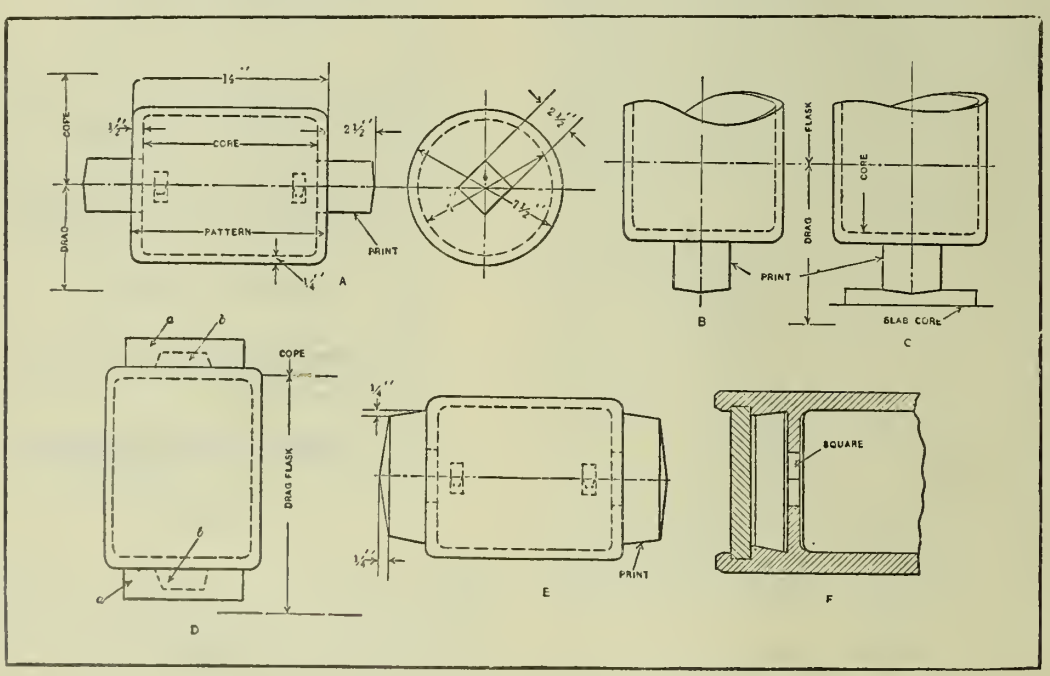
Writing in a recent issue of "Machinery," M. E. D. deals with the evolution of a pattern and core box for use in the production of large quantities of accurate cylinder or barrel castings. He states that the principal dimensions of the casting are shown at *A* in the accompanying illustration. The casting was to have core holes at each end 2½ in. square. It was desired to eliminate all machine work, and it therefore became necessary to hold the castings as close as possible to the specified dimensions.

Probably nine out of ten patternmakers would make the pattern with the parting line through the centre, and the 2½-in. core prints attached to the ends of the pattern, as shown at *A*, the core box being designed to produce half-cores that could be pasted together to form the complete core. A mould made from this pattern would, of course, be poured with the casting on its side in the position indicated at *A*. The first pattern was actually made and used in this way, but it proved unsatisfactory, as the core prints were not large enough to support the core or prevent it from rising in the mould when the casting was being poured.

The second method tried was moulding the pattern on end, as shown at *B*. This method was also a failure, because it was difficult to pass the core down through the mould and enter the print properly in the recess in the bottom of the mould. The end face of the core also proved too small to support the heavy core, so that the latter frequently sunk down into the moulding sand.

A slab core, such as shown at *C*, was then provided to overcome this difficulty. The slab core was rammed up in the mould in both the cope and the drag. This prevented the core from sinking into the moulding sand, but did not eliminate the difficulty experienced in entering the core in the drag. The core prints were next cut down to the size and shape indicated by the dotted lines at *b* in view *D*. "Ram-up" cores *a* were made to fit over the prints. These cores remained in the mould and provided a hard surface on which to set the core. The castings produced from this pattern were found to vary in thickness, due to the failure of the cope flask to line up properly with the drag. This method of moulding was therefore discarded.

The rather unusual method that was finally adopted with success was suggested by the foreman of the foundry. The pattern was made split through the middle and provided with core prints attached to each end, as shown at *E*. These prints were made 6½ in. in diameter, or ½ in. smaller than the diameter of the body core. The core prints were given a ¼-in. taper, as shown in the illustration. The core box for the pattern was made with ends of the shape shown at *F*, particular attention being given to the accurate tapering of the ends of the box. The core prints attached to this pattern were of sufficient size to support the core properly and hold it in place. With the split pattern and the tapering core prints, the moulder was enabled to mould the pattern either on its side or on its end, as desired.



Moulding a Barrel Casting.

Establising a Method of Testing for Green Bonded Strength.

By R. J. Doty, Vice-President and Works Manager, Sivyer Steel Casting Co., Milwaukee, Wis.

This Paper describes in detail methods which were tried out to accurately determine the relative green bonding strength of steel facing sands. The difficulties encountered were to secure repeatedly accurate uniform ramming of test bar of sand, and a method for pulling or breaking the test bar which would give consistent checks agreeing with the known physical properties. Various shapes of core boxes and methods of ramming were tried out, as well as methods of pulling or breaking the bars.

A method was finally derived, whereby using a core box 16 in. x 3 x 2 1/16 in. in height, producing a core after ramming 16 in. x 2 in. x 1 in. was developed, the bars being broken by a transverse stress. Several transverse and tensile testing methods were tried out, all except one method giving maximum deviation of from 13.75 per cent. to 33.60 per cent. A transverse method was finally decided upon, it giving a maximum deviation 9.35 per cent. and an average deviation of 6.66 per cent.

It was found that by using a volumetric method of measuring the sand used in filling the core box, that as the clay per cent. was increased actually less sand and clay was contained in the bar. This condition was caused by clay films around the sand grains increasing the average fineness of the sand particles. A gravimetric method of measuring the amount of sand to be used in the test bar was finally adopted and the results checked up with practical experience of the shop. By using this check testing of facing strength, uniform facings are produced, and troubles formerly encountered from the use of nonuniform facings eliminated.

This Paper is illustrated by the use of tables, charts and photographs.

* Extract of a Paper read before the American Foundrymen's Association.

IRON AND STEEL MARKETS.

Pig-iron.

With general holiday-making prospects imminent in the near future, the outlook in the pig-iron markets indicates a temporary postponement of an expansion of demand sufficient in volume to justify the immediate re-lighting of furnaces, although in some districts preparations for this purpose are already well advanced. Meanwhile, a much more confident tone can be reported in markets generally, while with few exceptions outputs are well absorbed by current requirements. In the Midlands makers are anticipating an early reduction of stocks of iron accumulated of late, but buying is still restricted to immediate necessities, very few forward transactions being recorded, consumers apparently retaining the impression that delayed purchases may be arranged on more advantageous terms. Foundry iron continues in slow demand, consumers of that quality awaiting the return to full activity of the engineering branches, necessarily a slow process after the prolonged suspension of the industry. The outlook for forge iron is, however, regarded as more encouraging, reports that a number of South Staffordshire finishing mills are to be put in operation suggesting an early revival of demand. The Cleveland market has as yet hardly recovered from its recent inaction, while business remains quiet in most sections, having so far failed to realise expectations of an early improvement, which, however, may probably develop within the next few weeks. There has been of late a better inquiry for Cleveland pig from Scotland, but in view of the near approach of the Glasgow Fair holidays, buying on that account has only been on a restricted scale. Business in the export section has been fairly satifactory, the June shipments of pig-iron from the Port of Middlesbrough, including Skinningrove, having turned out better than anticipated, the total amounting to 44,802 tons, as compared with 42,103 tons, an increase of 2,699 tons. The Skinningrove total was 2,922 tons. The coastwise shipments amounted to 9,140 tons, and the colonial and foreign to 32,740 tons. Teeside ironmasters, at a conference on Tuesday afternoon, decided immediately to discontinue fixing quotations for Cleveland pig-iron, so that there is once more an open market, and prices will be a matter of individual negotiation.

The Tees-side market for hematite is again quiet, home demand with the exception of South Wales continuing inactive, and though some shipments are going to Germany, Continental business is quiet, and stocks at furnaces are heavy. The committee of associated makers have fixed 94s. as the price of East Coast mixed numbers, but there is a free market for export, for which quotations are weak and irregular. While 92s. is reported to have been done, about 92s. 6d. to 93s. per ton, f.o.b., represents a general quotation. Similar conditions are marked in the case of West Coast brands, with prices unchanged at 115s. for Bessemer mixed numbers delivered Sheffield or Clyde side.

Finished Iron.

At last week's Birmingham market prospects in the finished iron section were regarded as more favourable than for some time past, and the general tone throughout was distinctly encouraging. Reports of extensive works long idle again resuming operations, and mills restarting in the South Staffordshire area, confirm apparently the more hopeful view entertained of a revival of business, accelerated it may be assumed by the fact that production costs have at length been reduced to levels leaving a profit at the prices now quoted. Makers of bars, and particularly in the common branches, consumers engaged in the nut and bolt and the fencing industries, instead of buying from hand to mouth are anticipating requirements over the next few months. Belgian exporters are again in keen competition in the market by reducing quotations, but home makers are more favourably placed in the matter of deliveries. The mills are fairly well employed, and sellers show an inclination to adopt a rather firmer attitude in respect to prices. Marked bars are based at £13 10s., and inquiry has expended, though the mills could do with more orders. In the West of Scotland the impending holidays have retarded developments for the time being, makers of finished material anticipating at least ten days suspension of business. Prices, however, are somewhat weaker, the Scottish Malleable Iron Makers' Association announcing a reduction of 10s. per ton in the home prices of iron bars. Crown bars are now £10 10s., and best bars £11 per ton, delivered in Glasgow.

Steel.

Slow, but steady recovery is in progress in the steel trade generally, but some time must naturally elapse before anything like normal conditions are restored. It is, however, probable that a moderate volume of business is held over until the completion of the half-yearly stock-taking, general in the trade at this season, when deliveries and production are usually necessarily at a minimum. Notwithstanding these drawbacks, there are unmistakeable signs of a revival of active conditions in sight, though even the most sanguine observers do not anticipate any striking change in the position until at the earliest the autumn season, and then, perhaps, entirely dependent upon the ability of makers to survive the financial strain after the prolonged idleness of the past months. In the semi-product section, business presents a more encouraging aspect than in other branches, the Sheffield market reporting substantial sales of billets consequent upon increased activity at the rolling mills. Local makers are now quoting £7 10s. and £7 15s. for soft basic qualities, although Lincolnshire brands can be bought a shade lower delivered, prices comparing favourably with Continental products. The position in the crucible steel branch is gradually improving, some fairly good orders from the States being reported, while the resumption of the engineering industry may be expected to revive activity in this direction. In the West of Scotland steel-makers have in many cases only sufficient work to keep them going for a short time, and very prompt deliveries can be promised. Steel sheet makers are hopeful of an improvement in conditions in the early future, now that the engineers are back to work, and locomotive and wagon builders are in a better position. Most of the work being done at present is, however, on export account, and the prices obtainable for the heavier gauges are unremunerative on account of the keen English competition.

Scrap.

Demand for all classes of scrap metal is still restricted, although in some localities a certain amount of quiet buying may be noted by consumers when opportunity offers to place business on advantageous terms. This tendency applies more especially in the case of the steel-making district, where more furnaces are going into use, the foundries generally not yet having initiated buying to any great extent. At Middlesbrough the following are approximate current quotations, all delivered works :—Heavy steel scrap, 60s. ; heavy cast-iron scrap, machining quality, 80s. ; do., ordinary, 75s. ; heavy wrought iron piling or bushelling, each, 60s. ; special heavy forge, 75s. ; steel turnings and cast-iron borings, each, 45s. per ton.

Tinplates.

A noteworthy feature of the week's business in the tinplate market has been the re-introduction of the "pooling" arrangement, the immediate effect being evidenced by a stiffening of prices all round. There has been a moderate volume of inquiries, but not much business has resulted so far, prompt parcels being mostly in demand, which have realised 19s. 6d. to 20s. basis. Makers' quotations for the basis sizes now rule :—Coke tins :—I C 14 by 20, 112 sheets, 108 lbs., 19s. 9d. per box ; I C 28 by 20, 112 sheets, 216 lbs., 39s. 6d. per box net, f.o.b. Wales. Terneplates met with a little more inquiry, a moderate business resulting at 18s. 6d. to 18s. 9d. basis for approved specifications, net cash, f.o.b. Wales. Wasters continue in good demand.

Metals.

Copper.—Messrs. Henry Bath & Son, Ltd., in their fortnightly metal report, state :—Great steadiness has ruled throughout the fortnight and the highest and lowest prices paid for standard show a maximum variation of only 7s. 6d. per ton. The principal feature has been the widening of the contango from 5s. to 10s. as the supply of cash warrants improved. Refined copper is still very scarce, and none is yet going into warehouse. In America also there seems a scarcity of copper for home consumption, and it would not be surprising to see prices advance there. There has been an improvement in the price of scrap copper, but only small quantities are now obtainable. Warrants of certain brands of rough copper ex Liverpool warehouses have been obtaining a premium of from 5s. to 7s. 6d. per ton. Current quotations.—*Cash* : Wednesday, £62 10s. ; Thursday, £62 7s. 6d. ; Friday, £62 18s. 9d. ; Monday, £62 17s. 6d. ; Tuesday, £62 18s. 9d. *Three Months* : Wednesday, £62 17s. 6d. ; Thursday, £62 16s. 3d. ; Friday, £63 7s. 6d. ; Monday, £63 6s. 3d. ; Tuesday, £63 7s. 6d.

Tin.—The range of values in this market, too, has been extremely small, highest and lowest prices paid during the fortnight only varying to the extent of 17s. 6d. per ton. The tendency is to consider present prices as fairly safe even in view of a probably considerable increase in the visible supply at the end of the month. There is litte doubt that consumption is improving gradually, though the coal strike in America is now beginning to have a bad effect there and that country has bought very little tin recently. She is well supplied, however, for the time being. The demand for tin ore remains unabated, but very little is reaching this country unsold. Current quotations.—*Cash*: Wednesday, £153 10s.; Thursday, £153 17s. 6d.: Friday, £154 5s.; Monday, £154 10s.; Tuesday, £153 10s. *Three Months*: Wednesday, £154 10s.; Thursday, £154 12s. 6d.; Friday, £155; Monday, £155 5s.; Tuesday, £154 5s.

Spelter.—This market has been uninteresting with only a small business and very little movement in prices. Some demand has been seen for early delivery, with the result that the backwardation has returned to 5s. per ton. Latterly fairly good buying of forward spelter has taken place quietly. The demand from galvanisers is showing a tendency to improve, and supplies are not plentiful. Current quotations.—*Ordinary*: Wednesday, £28 2s. 6d.; Thursday, £28 2s. 6d.; Friday, £28 2s. 6d.; Monday, £28 5s.; Tuesday, £28 7s. 6d.

Lead.—Business in soft foreign pig has not reached large dimensions, mainly owing to the scarcity of supplies. Very little June has been obtainable, and the firmness of the near position has induced fair buying of later months, particularly in view of the fact that though the present acute shortage may soon find some relief, there are no signs yet of abundant supplies. The heavy backwardation continues to hamper business. English lead is steady. Current quotations. — *Soft foreign (prompt)*: Wednesday, £25 5s.; Thursday, £25 5s.; Friday, £25 5s.; Monday, £25 5s.; Tuesday, £25 5s.

Trade Talk.

Mr. Theo. Affleck, engineer, has removed to the Belmont Engineering Works, Swindon.

F. Willis & Company, iron, steel and tinplate merchants, of Gorseinon, near Swansea, have removed to Witton Station, Birmingham.

The American Iron & Steel Institute have moved their offices from 61, Broadway, to the Barrett Building, 40, Rector Street, New York.

E. J. Hattersley & Company, steel manufacturers, formerly of 34, Edward Street, have removed to Central Steel Works, Brocco Street, Sheffield.

The British Insulated & Helsby Cables, Limited, are removing their London office from Lennox House to Surrey House, Embankment, W.C.2.

The Unity Engineering & Chemical Company, 94, Market Street, Manchester, have been appointed agents in that city for T. H. and J. Daniels, Limited of Stroud, Glos.

The Atlas Metal & Alloys Company (1921), Limited, formerly of 52, Queen Victoria Street, London, E.C.4, have removed to 1, Central Buildings, Westminster, London, S.W.1.

Hall & Pickles, Limited, Port Street, Manchester, have opened the following new branch offices:—Ipswich, 26, Princes Street; Leicester, 45, London Road; Lincoln, 22, Guildhall Street.

The River Wear Commission has arrived at an agreement with T. W. Greenwell & Company, Sunderland, for the construction and leasing of a new graving dock at the South Docks.

The connection between J. McIntyre & Company, old metal merchants, of 11, York Street, Liverpool, and their London agent, Mr. A. W. Sheffield, of 10, Camomile Street, E.C.3, has been severed.

G. S. Peckham & Company, of 4, New Compton Street, W.C., have been appointed sole agents for London and the South of England for the Patent Flexible Belting Company, Eldwick, Bingley, Yorks.

Two men were killed and three injured in an accident which occurred at the steelworks of Alfred Hickman, Ltd., Bilston, when a portion of a steel frame work which was being erected to house a new mill, suddenly collapsed.

Mr. C. Markham, chairman of the Park Gate Iron & Steel Company, Limited, has paid out of his own pocket a dividend of 5 per cent. on the shares held by the workpeople employed by the company, although no dividend is being paid by the company.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Barking Shipbreaking Company, Limited, H.M. Dockyard, Gillingham Gate, Gillingham, Kent; the District Waste Company, 81a, King Street, Wednesbury; the Erycdosa Tin Mines, Limited, Stafford House, King William Street, E.C.4; and Wm. Smith, 6, Abbotsford Road, Sparkbrook, Birmingham.

Vivian, Younger & Bond, 3, Abchurch Yard, Abchurch Lane, London, E.C.4, have registered the firm as a private limited company, under the style of Vivian, Younger & Bond, Limited, with a capital of £150,000 in fully paid shares of £1 each, the bulk of which will be held by the British Metal Corporation, Limited. The directors are Sir Cecil Lindsay Budd, Mr. Frank Kendall, and Mr. John Cecil Budd, and the two last-named will also act as managers.

Mr. I. B. Milne, owing to ill-health, recently resigned his position as chief of the Metallurgical Department at Hadfields, Limited. As a token of their esteem, his late staff and associates have made him a handsome presentation. Sir Robert Hadfield was unable to attend the presentation, but sent a letter of apology, in which he paid a striking tribute to Mr. Milne's ability and energy during their 34 years' association. Mr. Milne is retaining his seat on the board.

A memorial to the members of the Institution of Electrical Engineers who gave their lives in the war was unveiled on June 28 in the Institution Building, Savoy Place, by Air Chief-Marshal Sir Hugh Trenchard, assisted by the President of the Institution, Mr. J. S. Highfield, and the senior vice-president, Dr. W. H. Eccles. The memorial takes the form of two bronze tablets in the entrance hall, on which are inscribed the names of those commemorated. Sir Hugh Trenchard stated that more than 2,000 members of the Institution were on active service in the war. Apart from these, most of the remaining members were engaged in the production of electric machinery and power for the supply of munitions. Of those on active service, 162 lost their lives. More than 500 war decorations were awarded to members of the Institution.

Reviewing the year's work at the fiftieth annual meeting of the National Society of Brass and Metal Mechanics, held at Birmingham recently, the secretary said they had had many trying experiences, particularly in regard to wages movements. First the 12½ per cent. to day-workers and then the 7½ per cent. to piece-workers had to come off; then came the movement for the reduction of the 37s. 6d. war bonus applicable to the members employed in the brass and non-ferrous metal trades of Birmingham and district. This application was met by a move on the part of the Conciliation Board to obtain an agreement with the Birmingham Brassfounders Employers' Association to regulate wages on the cost of living basis. This movement was successful, the outcome being an agreed scheme to regulate wages by a sliding scale of 1d. per hour for every 12½ points, and ½d. per hour for every 6¼ points upwards or downwards, as indicated in the index figure for the cost of living. Certainly they had lost 21s. 6d., as against the 16s. in the engineering trade, but they had the greater satisfaction of an agreed regulated basis for controlling wages.

Output of Iron and Steel in June.

According to the usual monthly return issued by the National Federation of Iron and Steel Manufacturers, the production of pig-iron in June amounted to 369,200 tons, a decline of 38,700 compared with May. The number of furnaces in blast at the end of the month numbered 115, compared with 110 at the end of May. The production included 109,700 tons of hematite, 139,200 tons basic, 78,900 tons foundry, and 18,400 tons forge pig-iron. The production of steel ingots and castings also declined in June to 400,200 tons, compared with 462,300 tons in May.

The following table shows the average monthly production of pig-iron and steel ingots and castings in 1913, 1920 and 1921, and in each month since June, 1921:—

Average Monthly.		Pig-iron. Tons.	Steel Ingots and Castings. Tons.
1913		855,000	638,600
1920		669,500	755,600
1921		217,600	302,200
1921	June	800	2,700
	July	10,200	117,200
	August	94,200	434,100
	September	158,300	429,300
	October	235,500	405,400
	November	271,800	443,800
	December	275,000	381,000
1922	January	283,000	327,500
	February	300,100	418,800
	March	389,800	549,400
	April	394,300	404,200
	May	407,900	462,300
	June	369,200	400,200

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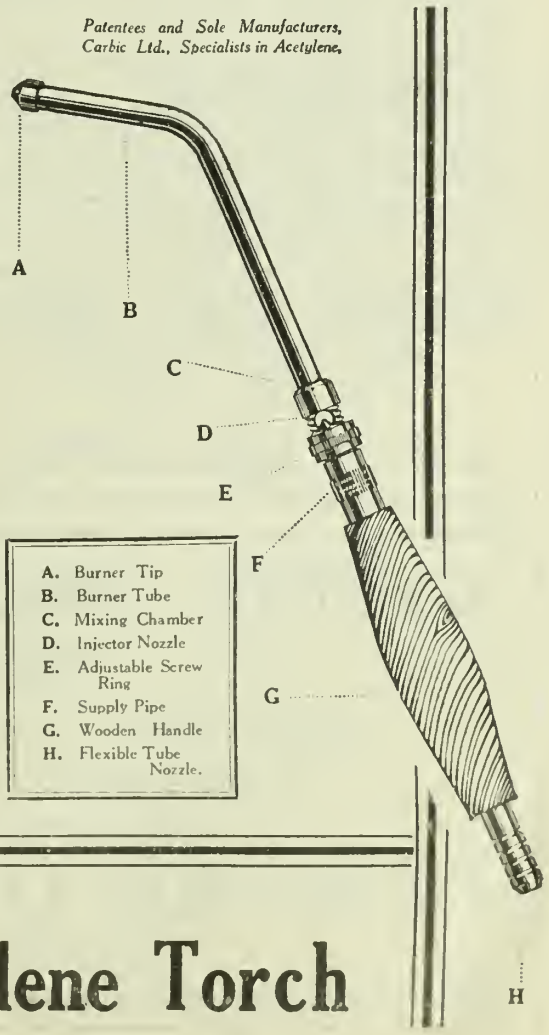

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Company News.

Birmingham Electric Castings, Limited. — Capital £2,000. Directors: F. Shutt, W. Shutt, and D. Pitt. Registered office: Kings Road, Hay Mills, Birmingham.

Vickers, Limited.—Profit, £708,103; brought forward, £991,639; preference dividend, £395,707; ordinary dividend, 5 per cent. per annum, less tax; carried forward, £872,994.

Chapman & Perry, Limited.—Capital £1,000. Iron, steel and tinplate merchants, etc. Directors: D. R. Chapman and C. S. Perry. Registered office: 32, Nassau Street, Dublin.

Burn Brothers (London), Limited.—Capital £50,000 in £1 shares (25,000 ordinary and 25,000 5 per cent. cumulative preference). Engineers. Registered office: 3, Blackfriars Road, S.E.

Chambers & Hammond, Limited.—Capital £15,000 in £1 shares. Chemical engineers. Directors: J. T. Wilman, E. V. Chambers, S. Wilman, and T. C. Hammond. Registered office: Lightcliffe.

Crompton & Company, Limited.—Net profit, £35,828; brought forward, £18,370; preference dividend, 7 per cent. for year; ordinary dividend, 5 per cent.; reserved for future taxation, £10,000; carried forward, £18,084.

Gibbons (Dudley), Limited.—Interim preference and ordinary dividends, 7 per cent. per annum, free of tax.

Northumberland Shipbuilding Company, Limited.—Dividend on cumulative participating preference shares deferred.

Maitland & Company (Kelvinhaugh), Limited. — Capital £20,000. Sheet metal workers, iron and steel founders, general engineers, etc. Directors: D. Maitland, T. A. Watt, D. M. Macfarlane, D. McGibbon, and W. Munro. Registered office: 222, Kelvinhaugh Street, Glasgow.

Vivian Younger & Bond, Limited.—Capital £150,000 in £1 shares. Metal merchants. Directors: Sir Cecil L. Budd (director British Metal Corporation, Limited, and Eastern Smelting Company, Limited), chairman; F. Kendall, and J. C. Budd. Secretary: F. C. Bell. Registered office: 3, Abchurch Yard, E.C.4.

Agricultural & General Engineers, Limited.—Taxation charges, £64,621; head office administration and selling expenses, £86,940; interest on sums advanced, £31,344; loss for year, £216,961; preference dividend deferred; arrears of dividend, less tax, to March 31, on 8 per cent. and 6 per cent. cumulative preference, £43,185.

Personal.

The late Mr. J. Marshall, of Marshall, Sons, & Company, Limited, engineers, Gainsborough, left £178,485, including net personalty £171,685.

The late Mr. H. E. Hollis, of Glasgow, a director of Arthur Balfour & Company, Limited, Dannemora Steelworks, Sheffield, left personal estate valued at £12,682.

Mr. M. V. Ward has resigned his directorship of I. S. M., Limited, iron and steel merchants, of 61, Goswell Road, London, E.C.1, and is no longer connected with that company.

Mr. T. Coverdale, assistant train-master (freight section), Middlesbrough, who entered the service of the North-Eastern Railway Company at West Hartlepool, in the early part of 1871, has retired.

Mr. Adams, of Rotherham, after 30 years service as the manager at the works of William Oxley & Company, Limited, Parkgate, retired on June 30. He has been the recipient of a presentation from the officials and men.

Vice-Admiral Sir George Goodwin, the late Engineer-in-Chief of the Navy, has been elected to a seat on the board of directors of Richardsons, Westgarth & Company, Limited, of Hartlepool, Middlesbrough and Sunderland.

Mr. D. W. Turner, late general manager and director of the Midland Railway, Carriage and Wagon Company. Limited, who is also associated with Cammell, Laird & Company, Limited, has been elected chairman of the Wellington Tube Works, Limited, Great Bridge, Staffs.

Mr. D. Bevan, Hendre, Llangennech, has died at the age of 61 years. The deceased gentleman was brought up in the tinplate industry under the late Mr. William Williams, M.P., at Morriston, and when that gentleman gave up his interests in the Morlais Tinplate Works, Llangennech, Mr. Bevan formed the present company. He acted for many years as manager, but he relinquished his duties in favour of his brother, Mr. T. Bevan. Afterwards the deceased gentleman became interested in the Grovesend Steel Works, as well as the Raventon Works (Glanamman) and the Hendy Tinworks at Pontardulais.

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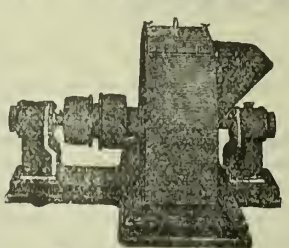
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THE

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Contents.

	PAGE
Apprenticeship Courses	45
British Industries Fair, 1923	45
An Apprenticeship Course in Fonndry Practice.—I.	44
The Development and Manufacture of High Tenacity Brass and Bronze	47
British Iron Ore Resources	49
American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product	50
Publications Received	53
Book Review	53
The Training of Foundrymen	54
Correspondence	58
American *versus* British Grey Cast Iron	59
Display Facilities for British Travellers in New York	63
Contracts Open	63
Trade Talk	64
Company News	64
Gazette	64
Iron and Steel Markets	66

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Apprenticeship Courses.

In this week's issue, we commence a special series of articles designed to form a course of instruction suitable for all grades of foundry apprentices. Additionally, a Paper by Mr. Liardet, given before the West Ridings of Yorkshire Branch of the Institution of British Foundrymen, on a system of education of such youths is also given. This particular system has been evolved by an industrialist and not by an educationalist, and has much to commend it. It includes evening classes, and if any boy wishes to make progress he must be made to realise that nothing is gained without hard work. No person will make substantial progress working only from eight in the morning to five at night. If classes are given during the day involving a minimum of sacrifice on the part of the apprentice, then the appreciation of the apprentice varies directly with that sacrifice. In plain words, if things are made too easy facilities are not appreciated. We would point out that there are a considerable number of world-renowned metallurgists who have received the whole of their theoretical training at evening classes. We do not want to moralise, but managers might well point out to apprentices that there is plenty of room at the top of the tree; it is only the bottom which is crowded. We are minded to say this, as some pertinent remarks on the subject were made by Mr. Wilkinson, of Birmingham, who rightly emphasised the importance of sympathetic interest on the part of the foundry manager. Boys in foundries are not usually there by choice, but by force of circumstances, because conditions in the past have not been such as to attract the best type of lad.

Now, nearly all boys glory in two things: practical chemistry and furnace work; and we suggest that these two subjects should be tackled very early in his apprenticeship. We notice Mr. Liardet's scheme provided chemistry very early on. That is certainly very desirable, and it should be followed immediately by the practical participation in melting processes. The students will learn more about metallurgical calculations and processes on a furnace charging-platform in an hour or two than in several lectures. Owing to the absence of restriction, any boy not being quite clear gets his information in his own way, either by direct application to the demonstrator or to another student.

The object of the installation of plant and laboratories in technical colleges is not to give practical instruction. That can only be gained in the works; but they help to bring the student and lecturer into closer association and to make the lectures much more interesting and intelligible.

Now, the instruction which will be given in the series of articles has not for its object the replacing of instruction given in technical classes. It will be auxiliary and helpful alike to instructor and teacher. Mr. Gallon pointed out, when discussing Mr. Varlet's Paper at Birmingham, that very few foundry boys can visualise a drawing. Such instruction cannot be included in the series of articles now commencing. The main object of these articles is to interest the lads in their work by supplementing the practical information they obtain in the foundry or pattern shop and the evening classes.

British Industries Fair, 1923.

We have received from British Industries Fair (Birmingham) Incorporated a copy of the prospectus of the Fair to be held in Birmingham from February 19 to March 2, 1923.

The Fair, which is only open to exhibits made by British manufacturers and to British wholesale firms taking the whole output of a British factory or holding the sole selling rights of patented or proprietary articles manufactured in the British Empire, is divided into eleven groups, including brassfoundry, hardware, and ironmongery, all descriptions of ferrous and non-ferrous metals and alloys, General machinery, machine tools, engineering and industrial tools; sheet-metal machinery, etc., etc. Foundry appliances and requisites; malleable ironfoundry, drop forgings, die castings; general castings; wire, tube, and rolling-mill plant; hydraulic plant; scales, balances, and other weighing instruments; measuring and testing instruments and appliances; heat treatment of metals, etc.

The Secretary is Mr. G. Henry Wright, F.C.I.S., and the registered office is at the Chamber of Commerce, 95 New Street, Birmingham.

An Apprenticeship Course in Foundry Practice.—I.

By Ben Shaw and James Edgar.

PATTERN-MAKING MATERIALS.

It may be as well to make it quite clear in the opening sentence that these articles are intended for young journeymen and apprentices—especially for apprentices. The writers have been impressed in the course of their experience with the lack of knowledge among their fellow craftsmen of the materials used by them, and also of the principles of the various operations employed. The endeavour will be to discuss the properties of materials and describe methods of construction in a simple, lucid fashion, and any piece of work—generally of a simple kind—that is described will be used simply as the instrument of convenience which for the purpose may be more effective in conveying what is meant than a description in abstract.

In discussing the proportion of pattern-making materials we begin at the very genesis of foundry work. The resultant castings depends to a considerable extent on the quality of the pattern, and this in turn depends on the quality of the material used.

The Chief Material.

Timber is the most important pattern-making material, and yellow pine for all but small work or medium-sized work from which it is contemplated that a quantity of castings will be required, is almost universally used. It is a mellow, comparatively straight-grained wood, fairly free from knots and shakes, and easily carved. It does not warp or absorb moisture to anything like the extent of the open-grained spruce, which should never be used for pattern-making. Spanish mahogany makes good small patterns, but it is seldom used, quite a good substitute being found in American baywood or Honduras mahogany. Teak is used in some pattern-shops, and it has some outstanding qualities. It does not warp much, and the natural oil it contains assists in preventing the absorption of moisture; it is, therefore, not liable to shrink or swell, but, on the other hand, it is rather brittle, and edged tools require very frequent attention when working it. Cypress and red pine are used as small quantities, as also are sycamore, maple, plane tree, lime tree and cherry. Sycamore, maple, or plane tree are tougher and more pliable than mahogany, and they are sometimes given preference for small or standard work on that account. Both lime and cherry are particularly useful when much carving is to be done, very fine edges standing considerable wear without damage. Though these woods are used to a limited extent, they invariably take more time to work than baywood. Lignum vitæ is not actually used for making patterns, but pattern-makers often bush stern-tubes in marine shops, for which purpose this hard timber is always used because of its self-lubricating properties.

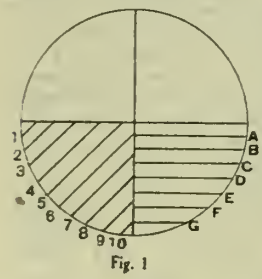


Fig. 1

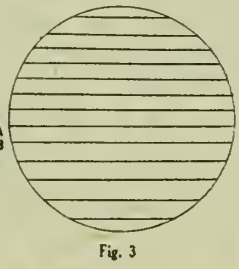


Fig. 3

Hard and Soft Timber.

A great deal of research work has been carried out in order to find satisfactory wood preservatives for construction work, but the pattern-maker is not much concerned about that; patterns are preserved by the methods adopted in constructing them, and also by the paint or varnish used in coating them. The question of hardness is an interesting one. It is rather difficult to get out a table showing comparative hardness of various woods, but the following is sufficiently accurate for practical purposes. Some of the woods are never used by the pattern-maker and others but seldom, but a comprehensive knowledge of the subject is of value:—

Very soft—Linden, poplar, willow.

Soft—Pine, fir, larch, alder, horse chestnut.

Somewhat hard—Beech, oak, walnut, pear, apple, chestnut.

Fairly hard—Ash, plane, plum, elm.

Hard—Maple, yolk-elm, wild cherry, sycamore, yew.

Very hard—Almond, hawthorn.

Hard as bone—Lilac.

Harder than bone—Lignum vitæ.

Hardest—Ebony, which is as hard as stone and very tough.

Specific Qualities of Various Woods.

Spruce or white fir, as it is frequently called, grows in North America and Norway chiefly. It is at its best when about 80 years old. Many species of spruce trees are found in our public parks. Neither of the two varieties which are known as American or Baltic spruce, is durable. Red Pine is another American variety which is more used by joiners than pattern-makers because it is much stronger than yellow pine. Yellow pine is imported chiefly from America. The tree grows to a great height and logs 70 ft. long and 24 in. wide are easily obtained. It has been described as the finest, softest, and most easily worked timber obtainable, and this is not an exaggeration. It contains very little resin, and its texture is very even, which renders it particularly suitable for patterns. It is graded according to quality, like most other timbers, and although the best quality is not always used for pattern-making, it ought to be for high-class work. Pitch pine is not suitable for pattern-making at all, as it so readily absorbs moisture. A pitch-pine pattern tears the sand and necessitates a great deal of patching by the moulder after the pattern has been withdrawn from the mould. The ridged surface which results after a pitch-pine pattern has been used a few times is because of the hard and soft annular rings. The soft light rings shrink, while the hard or dark rings retain their shape, or the soft rings absorb more moisture which causes them to swell beyond the hard grain. Much need not be said about true mahogany, by which reference is made to that which is imported from the West Indies, because very little of it is used. At different times over 60 varieties of timber have been sold as mahogany, Baywood, which is the "mahogany" most used in pattern-shops, grows about the Bay of Honduras in Central America. It is in every way a satisfactory timber. It takes glue as well as yellow pine, has a very even grain with little difference in texture, and it works well. It is straight-grained, and not liable to warp or twist, and if it has been well seasoned it is durable. With regard to the grading of timber no standard is possible, and a timber merchant's grading is not always a bona-fide indication of good or bad quality.

Timber Merchants' Terms.

In the pattern-shop all the timber is in the form of boards or planks, but it is not always bought in this form. It is as well for pattern-makers to know the technical terms used by timber merchants for timber of different sizes. Board is the name given to any kind of wood of whatever length and width that does not exceed 2 in. in thickness, while a deal is 9 in. wide and not more than 4 in. thick, and a batten is 7 in. broad and not over 4 in. thick. Quartering is the term used for narrower material not over 4½ inches wide or thick, whilst a plank is 11 in. or more wide and from 2 in. to 6 in. thick. Yellow pine is usually sold by the Petrograd standard, which is 165 cub. ft. or 720 planks 11 in. by 3 in. and 12 ft. long. The hard woods are usually sold by the foot run or by the superficial foot, which means 12 in. by 12 in. by 1 in., while exceptional woods, such as Lignum vitæ, are frequently sold by weight. The trunk of a tree with all

its branches removed is called a log, and after it is roughly squared it is known as a baulk. If a log is sawn up the centre the parts are called flitches, and this term is also applied if it is sawn in parts over 6 in. thick. It may be pointed out the quarter sawing is not synonomous with quartering, but is given to the method of sawing a log into four quadrants, as indicated by the lines in Fig. 1. Each quarter is then sawn into boards, as indicated by the lines 1, 2, 3, etc. This is a wasteful method, and is not very often employed. Fig. 2 is chiefly of interest to pattern-makers as showing the scientific cutting as adopted by some timber companies to prevent waste, and at the same time obtain a suitable grain for varying purposes.

The conversion of timber is done in many ways; Fig. 3 is the most economical method, but not the most satisfactory. The centre or heard board does not warp, but the thickness at the centre and edges will vary. The other boards will warp as a cross section of timber, say yellow pine, is examined under a microscope, or, better still, microphotographed, it would be found that there are innumerable cells, and that the cells which represent the summer growth of the trees are much larger and more open than those that represent the winter growth. The defining line is quite easily distinguishable. The cells are filled with water, and the process of eliminating it is called seasoning. As the wood dries, the cell walls shrivel and the width of the timber becomes less. In length, however, there is no perceptible shrinkage. Timber cracks are nearly always radial or parallel with the medullary rays. Heart wood does not warp like outside timber. Timber cut in winter is superior because there is less sapwood, and an old tree has less sapwood than a young tree. It may be admitted that, however much a man may know of the theory of timber craft, practical experience is very valuable. An old hand will wet timber with his tongue, and watch it absorb the moisture, he

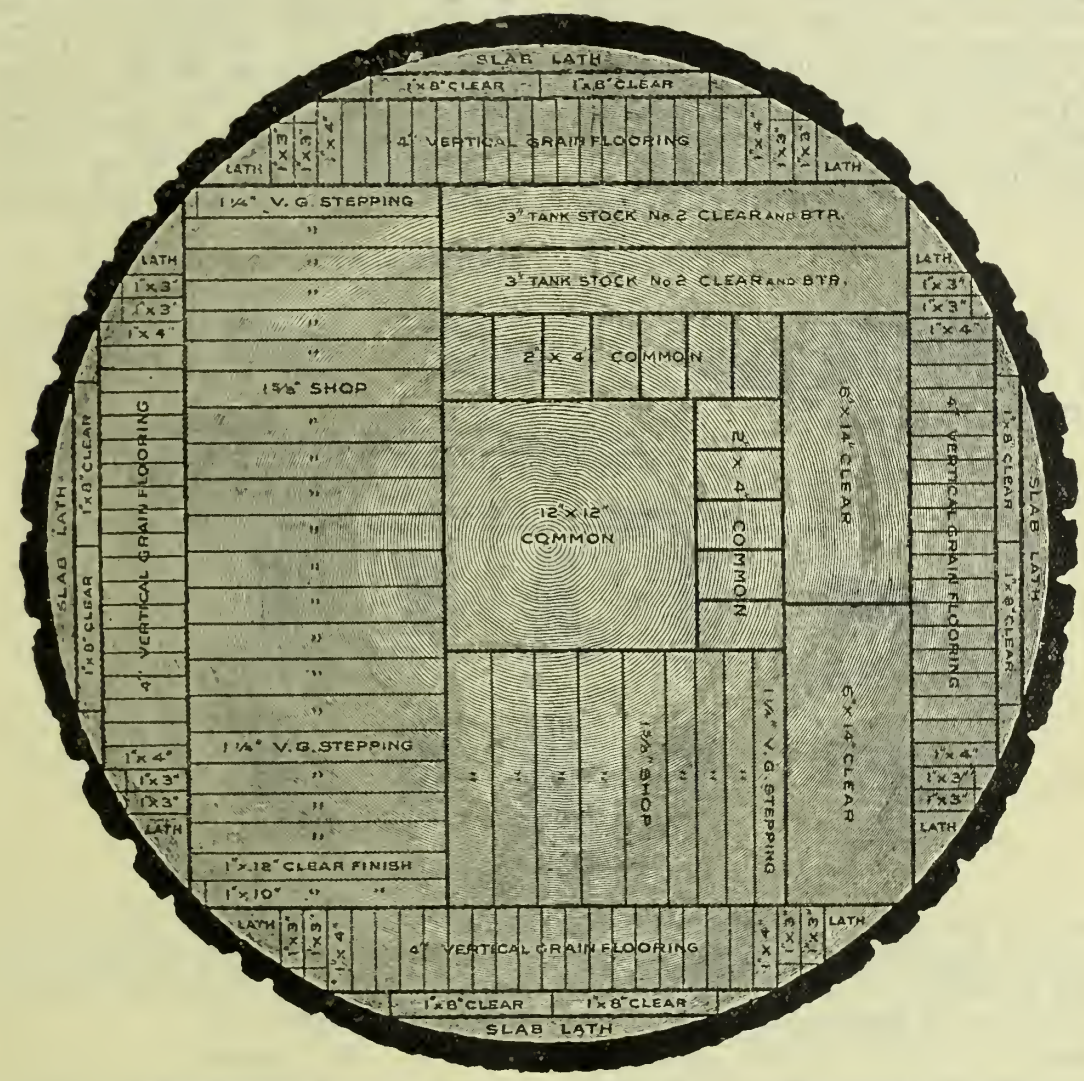


Fig. 2.—Chart Prepared by the National Lumber and Manufacturing Company, Hoquean, Showing Position in Log of Various Items.

shown, and the reason for the warping will be made clear later on. The method of quarter-saving and the ripping into boards is indicated by the lines E, F, H, etc. Fig. 1 gives better boards. Young trees have sometimes got a wandering heart, and boards cut from them will twist badly.

Important Definitions.

There are certain definitions apart from those used by timber merchants to describe different-sized boards which ought to be known to every pattern-maker, those that have to do with the trees' growth. What is the cause of shrinking, swelling and warping? If the end of a sawn log is examined, a number of rings more or less concentric with the outside of the log will be found, and these indicate approximately the age of the tree. These rings are called annular rings. There are radial lines resembling cracks, and these are usually called silver or medullary rays. Now, if may judge by smell, he may try its weight, and he will invariably inspect the end grain carefully.

Certain experiments may be tried from which much useful knowledge will be gained. One method, recommended by a timber expert, is to take two pieces of timber of equal size, one from the centre and the other from the side of the board, soak them in water for a few hours, and then dry them again. If the outside contains sap it will be much longer in drying.

Seasoning.

A great deal has been written on the seasoning of timber, and new processes are continually being discovered. Dry timber does not exist. Perfect dryness is a condition in which all moisture has been evaporated, leaving dry fibre and a minute amount of granular residue from the sap. The moisture content is always tested before the wood is placed in the kiln, in order that the time neces-

sary can be accurately calculated, and delicate scientific instruments are used for the purpose. The pattern-shop partially seasons its own timber by stacking it for a time in the open air or placing it in a drying shed. Very few pattern shops have a drying room, but there are some, and the drying is done too rapidly, with the result that when it is taken out and sent into the foundry, especially if unpainted, it immediately absorbs moisture and swells. The air seasoning of wood is an old practice. No really systematic attempt has ever been made (as far as the authors can ascertain) to work out the exact conditions to produce the best results. It is too often forgotten by pattern-makers that timber is stacked or racked to season it. We hope to discuss this at greater length in a subsequent article, but the pattern-maker ought to know something of the kiln-drying process which takes place before the timber reaches him. The U.S. Forest Products Laboratory, which has done more research work than probably any other body on either side of the Atlantic, states that the two things which a kiln operator must be able to prove at the end of a kiln run are that his timber is as dry as is required, and it is free from invisible seasoning stresses which would cause warping when the wood is re-sawn and shaped into patterns. Neither of these points can be proved by examination of the outside of the timber. They are easily determined, however, by the following tests, and although the pattern-stock should be equalised by steaming, if necessary, to within 2 per cent. before the timber leaves the kiln.

The third and fourth sections, C and D, are for case-hardening and moisture distribution tests. Saw section C parallel to the wide faces of the original board to form tongues or prongs, leaving about ½ in. of solid wood at one end of the section. If the stock is less than 2 in. thick make two saw-cuts; if it is more than 2 in. thick make five saw-cuts. From sections having six prongs break out the second prong from each side, leaving two outer and two central prongs. From sections having only three prongs remove the centre prong. In section saw one central saw kerf to form two prongs. Stand the section on end in some convenient place in the shop to dry. The action of the prongs from the moment of sawing should be observed carefully. Do they bow in or out or remain straight on the saw? Do they change shape after room-drying? If the prongs remain straight both on the saw and after room-drying the timber is perfectly seasoned, being free from stresses and uniformly dry throughout. If the prongs remain straight on the saw, but turn in after room-drying, the moisture distribution is uneven, the surface being drier than the inside. A short steaming treatment to balance the moisture content should relieve all stresses. If the prongs turn in on the saw, and do not turn out after room-drying, the timber is "case-hardened"

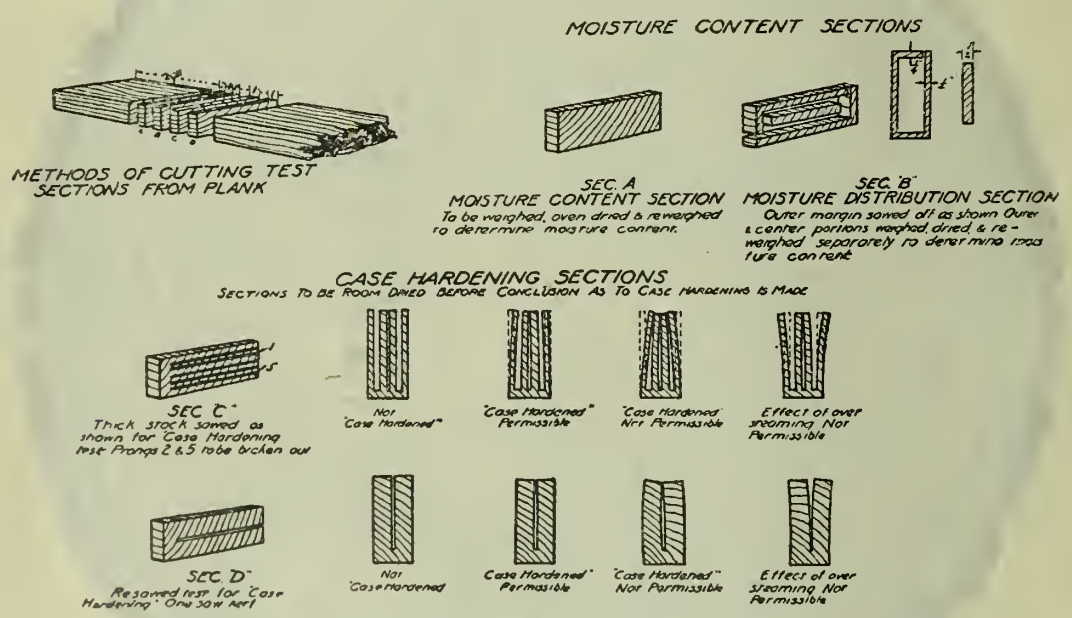

MOISTURE CONTENT SECTIONS
METHODS OF CUTTING TEST SECTIONS FROM PLANK
SEC. A
MOISTURE CONTENT SECTION
To be weighed, oven dried & reweighed to determine moisture content.
SEC. B
MOISTURE DISTRIBUTION SECTION
Outer margin sawed off as shown Outer & center portions weighed dried & re-weighed separately to determine moisture content
CASE HARDENING SECTIONS
SECTIONS TO BE ROOM DRIED BEFORE CONCLUSION AS TO CASE HARDENING IS MADE
SEC C
Thick stock sawed as shown for Case Hardening test Prongs 2 & 5 to be broken out
Not "Case Hardened"
"Case Hardened" Permissible
"Case Hardened" Not Permissible
Effect of over steaming Not Permissible
SEC D
Resawed test for Case Hardening One saw kerf
Not "Case Hardened"
"Case Hardened" Permissible
"Case Hardened" Not Permissible
Effect of over steaming Not Permissible

Fig. 4.—Test Sections for Moisture Content and Case-Hardening.

maker may never have to make these tests, the information is invaluable as showing what does happen given certain conditions. The full section A, Fig. 4, should be used to find the average moisture content of the dried stock. To do this, weigh on a balance the section immediately after cutting accurate to one-tenth of 1 per cent., and then dry it on a steam pipe or in an oven at 100 deg. Cent. until it reaches constant weight. The weight lost during this drying is the weight of the moisture by the weight of the oven-dried section, and multiply by 100. This will give the percentage of moisture in the section, and also in the stock in that part of the kiln from which the sample was taken. For pattern-making, the moisture content of any board in the kiln should not vary by more than 2 or 3 per cent. from the final moisture content specified.

Section B should be used to find out whether the stock is uniformly dry from centre to outside. In order to do this the section must be cut apart and the moisture content of the inside and outside found separately. If the stock is 1½ in. or more in thickness, cut the section parallel to its edges to get an outer shell of material ¼ inch thick. If the stock is less than 1¼ in. thick, cut section B so as to get an outer shell and inner core each one-fifth the total thickness of the section. Find the moisture content of each piece by the method used for finding the moisture content of section A. The moisture content of the inside and outside of the and is drier outside than inside. Use a steaming or high humidity treatment to moisten and soften the surface. The shrinkage of the outside in re-drying should relieve the interior tension and cause the stresses to disappear.

(To be continued.)

The Treaty of Versailles and Public Works in France.—The programme of the first section of works of public utility, which the French Government suggests that Germany should be asked to execute in France, in virtue of Article 19a, Annex 2, of the Treaty of Versailles, shows that five schemes are planned, as follows:—(1) The harnessing of the Rhône; approximate cost 3,250,000,000 fcs. (2) The regulation of the Truyère; estimated cost 210,000,000 fcs. (3) The regulation of the Dordogne; estimated cost 270,000,000 fcs. (4) The construction of a tunnel between Saint-Maurice and Vesserhagne, 3.26 km. (about two miles) long in the Vosges; estimated cost 64,000,000 fcs. (5) The construction of two parts of the North-East Canal (junction canals: Sarre-Moselle-Meuse and Meuse-Escaut); estimated cost 1,100,000,000 fcs. Total cost, about £100,000,000, including contingencies. The financial charges are to be divided as follows:—France about 19 per cent., Germany 81 per cent. The work is estimated to last four years in the case of the Truyère scheme; four years at the Dordogne; and five years at the Vosges tunnel. The scheme is being submitted to the Reparations Commission for their approval.

The Development and Manufacture of High-Tenacity Brass and Bronze.*

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

It is intended in this Paper to treat synthetically the development of complex high-strength brasses and to consider the principal problems of manufacture. In the past these alloys were termed "manganese bronzes," and in specific cases prefixed by either the inventor's or a trade name. This no doubt arose from their complex nature and costly practical evolution. At the same time it is a misnomer and surrounds them with an air of mystery which retards rather than advances their progress.

The base of practically all the so-called "manganese bronzes" is brass, and they do not derive their special virtues from manganese. The Institute of Metals has suggested the name "brass," preceded by the name of the special elements introduced, *e.g.*, the presence of aluminium would identify it as "aluminium brass," manganese as "manganese brass," if both these elements are present as "aluminium-manganese brass," and so on. This is a step in the right direction, and the recommended appellation will be adopted throughout this Paper.

To understand the function of the numerous special elements commonly introduced, viz., aluminium, manganese, iron, nickel, etc., a working knowledge of the constitutional diagram of the copper-zinc series of alloys is essential.

This diagram is generally avoided by the foundryman and engineer on account of its formidable appearance and the adoption of Greek terms. Yet it presents a fund of information which may be readily interpreted by anyone interested.

Fig. 1 shows both the constitutional diagram and the physical properties of the pure copper-zinc series of alloys in the "cast" state.

Considering the interpretation of the constitutional diagram only, *i.e.*, the thin black lines, from lines ABCDE the melting point of any brass may be obtained; increase the temperature by 10 to 12 per cent. and a good idea of the correct casting temperature is obtained. From line AFMNOQ the temperature of complete solidification. The difference of temperature between these two lines is a measure of the range of temperature through which any brass cools during solidification. Area enclosed by AFHG, including all brasses to 37.2 per cent. zinc, shows that those containing up to 30 per cent. zinc will proceed, uninterrupted by any subsequent physical changes after solidification, *i.e.*, they will consist of a single homogeneous solid solution of copper and zinc at all temperatures. This solid solution is termed "alpha" brass, and for all practical purposes is unaffected by the rate of cooling.

Exceeding 30 per cent. zinc, another constituent appears alongside with the "alpha," and for want of a better name is termed the "beta" constituent. As the zinc content increases, the greater the quantity of the "beta" and the less the quantity of "alpha," and between 46.7 per cent. and 49.7 per cent. zinc none of the "alpha" constituent exists, but only the "beta." This is clearly shown by Figs. 3 to 6, representing 65/35, 60/40, 55/45, and 53.3/46.7 brasses respectively, cut from 2½ in. sq. ingots.

In the 30 to 37.2 per cent. zinc series of brasses the line FHG marks where they pass from a region in which both the "alpha" and "beta" phases can exist side by side into the main "alpha" zone, where this constituent alone is stable. The "beta" constituent must then exist in a metastable state, and, if normally cooled, changes into the "alpha" phase on the alloy passing through the temperature represented by that point on line FHG.

If, now, a brass of this series is quenched in the "alpha beta" area, FHIM, and the rate of cooling is such as not to permit the natural change from the "alpha beta" to "alpha," then a duplex structure will be formed, and the brass will be hardened to an amount determined by the percentage of the "beta" constituent present.

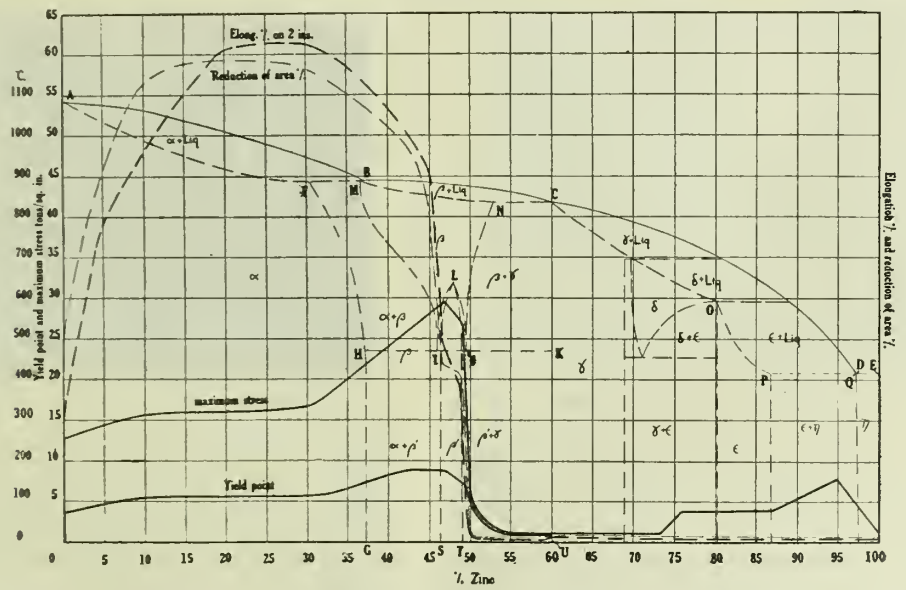

Elong. % on 2 ins.
Reduction of area %
maximum stress
Yield point
Yield point and maximum stress tons/sq. in.
Elongation % and reduction of area %
% Zinc

FIG. 1.—CONSTITUTIONAL DIAGRAM OF PHYSICAL PROPERTIES OF CU-ZN ALLOYS "AS CAST."

This point has been somewhat elaborated to demonstrate that brasses containing between 30 to 37.2 per cent. zinc are affected by heat treatment, and though not of practical importance, so far as improved mechanical properties are concerned, an understanding of these physical changes explains many of the defects common to these brasses. A further feature of this series is that they can be worked either hot or cold.

Exceeding 37.2 per cent. and up to 49.7 per cent. Zn a complex state of affairs exists, and the "beta" constituent remains stable at all temperatures.

The physical changes shown to take place after solidification by region FMNCUG are not strictly correct, and are subject to alteration of academic rather than practical importance. Brasses containing 37.2 to 46.7 per cent. Zn being possibly the most important series of the Cu-Zn alloys form the basis of all high-tenacity brasses, and consist of both the "alpha" and "beta" constituents. If quenched from high temperatures—*i.e.*, tem-

C

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

peratures above the line IM—the change from "beta" to the "alpha beta" is suppressed. Such brasses, then, may have an all "beta" structure—*i.e.*, their physical properties may conform in many respects to brasses containing between 46.7 and

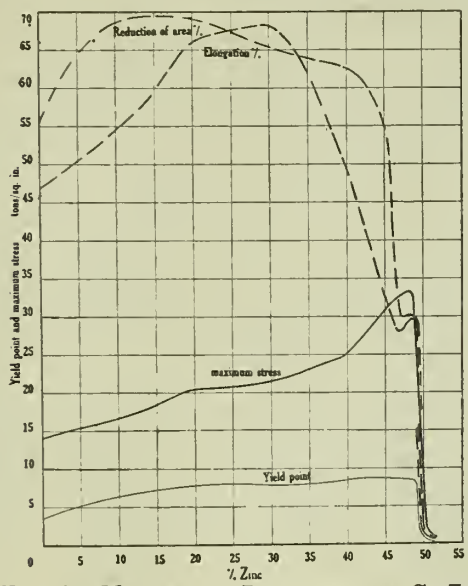


Fig. 2.—Mechanical Properties of Cu-Zn Alloys after Treatment.

49.7 per cent. Zn. It is also evident that the nearer the zinc content to the limit 46.7 per cent. the lower the temperature necessary to effect this physical change.

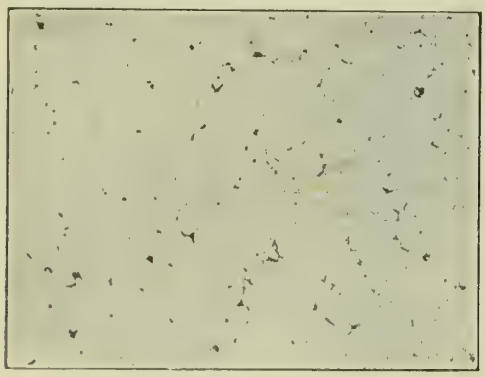


Fig. 3.—65/35, Brass as Cast.

The next group of alloys to be considered are those containing 46.7 to 49.7 per cent. Zn. These have little commercial value. Their constitution is ambiguous. According to the accompanying diagram, the region of true stability of "beta" brasses is confined to temperatures above 470 deg. C., and whilst it must be admitted, by the inclusion of line HJ IK, that some critical change does occur at these temperatures, which the author

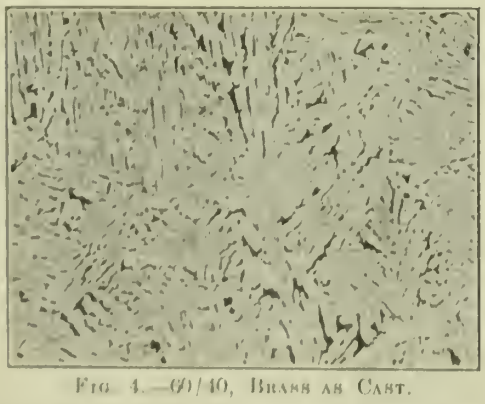


Fig. 4.—60/40, Brass as Cast.

has never been able to demonstrate by heat treatment alone, that they mark the transition of the "beta" constituent into its component parts, "alpha" and "gamma," as is commonly alleged. That some critical change does occur at or about 470 deg. C. is supported by: (1) It marks the true limiting forging temperature of practically all the "beta" brasses; (2) it indicates the temperature of incipient heat fragility; (3) it is the correct annealing temperature for practically all pure brasses.

It is of interest to note at this stage that it is brasses which enter into region MIJN—*i.e.*, the "beta" brasses, which specially lend themselves to working hot, whilst those consisting of only the "alpha" constituent are peculiarly suitable for working cold.

Exceeding 49.7 per cent. Zn, a new constituent, gamma, makes its appearance. This is a hard, brittle alloy, and its inception in the most minute traces renders brass extremely brittle and useless as a material of construction. So brittle is the "gamma" phase that an alloy containing 60 per cent. Zn—*i.e.*, all "gamma"—may be crumbled between the fingers.

The thick black lines, Fig. 1, show the physical properties of pure brass, correctly cast in chill moulds; and in Fig. 2, the physical properties after mechanical and thermal treatment, such as to remove completely casting structure, internal strain and heterogeneity. In short, No. 1 may be used as a standard of the physical properties of brass castings. No. 2 to rolled, extruded and forged brass when correctly annealed.

Development of High-Tenacity Brass.

In this research constant conditions were maintained throughout, eliminating all variables except the one desired, viz., chemical composition. For this reason virgin metals and specially prepared stock alloys were used, the chemical compositions of which are given in Table 1. Two grades of zinc were adopted, owing to the uncertain test-figures previously obtained from cast-

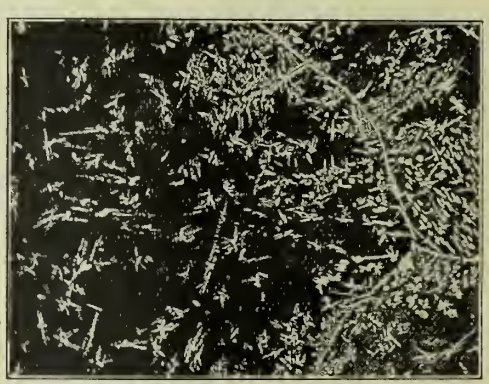


Fig. 5.—55/45, Brass as Cast.

ings and forgings made with the lower grades of spelter.

Owing to the difficulties of obtaining standard conditions with a sand mould, each casting was made in a 2½ in. sq. chill mould, pouring with exactly 10 per cent. superheat and controlling the temperature of the mould at exactly 130 deg. F. (55 deg. C.).

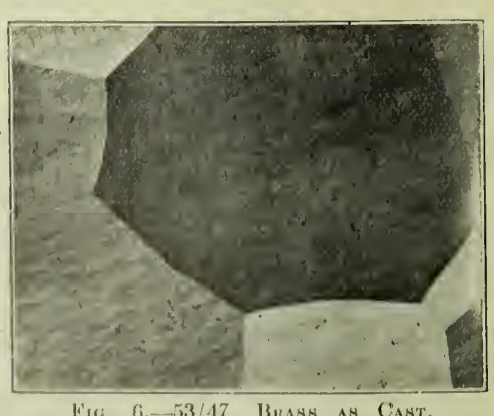


Fig. 6.—53/47, Brass as Cast.

Physical Tests.—Tensile tests were prepared in accordance with the specification of the Engineering Standards Committee, the area being 0.25 sq. in. and the gauge length 2 in. A permanent set of 0.01 in. is recorded as the yield point.

Hardness. The Brinell ball-test and the Shore scleroscope were used for this purpose. The former

being made with a 10 m/m ball under a pressure of 1,000 kgs., maintained for exactly 30 sec., whilst the latter were made with a soft hammer.

In order that complete data should be obtained both regarding the peculiarities of manufacture and mechanical properties, each alloy was made under works conditions. Melting was performed in a 50 or 100 lbs. crucible, according to the size of casting, in a natural-draught coke furnace.

The method of introducing the various special metals investigated, and the precautions necessary, will be detailed under each distinctive heading. These, by no means arbitrary or exhaustive, represent a practice that has withstood the test of time and can be commended.

Mechanical Treatment.—Where it was desired to investigate in the forged or heat-treated condition, the lower half of the ingot was forged into 1 in. sq. bars. In the case of cold-working alloys, a 100-lb. ingot was cast 1.05 in. by 4 in. wide. The lower half was cold rolled in three passes to 0.55 in., annealed at the correct temperature,

British Iron Ore Resources.

The Imperial Mineral Resources Bureau have issued three more parts of a series of volumes dealing with the present and prospective iron-ore supplies of the world.* Part 3 deals with British America. The section dealing with Canada is based on a Special Report (dated 1920) to the Imperial Mineral Resources Bureau by the Canadian Minister of Mines, and the two volumes issued in 1917 by the Canadian Department of Mines on the "Iron Ore Occurrences of Canada"; it extends over eighty-five pages. The ores of Newfoundland are dealt with on further twelve pages. In the West Indies iron ore has been recorded only on Trinidad, and the deposits there are briefly described. No deposits have as yet been discovered either in British Honduras or the Falkland Islands. Magnetic ironstone has been found in British Guiana, and large areas in this Colony are covered by superficial deposits of lateritic ironstone low in phosphorus.

TABLE I.—*Analyses of Materials Used.*

Material.	Zn.	Cu.	Pb.	Fe.	Si.	Al.	Sn.	Cd.	O.	P.	Co.	Ni.	As.	M.
Zinc (Crescent Brand) ..	99.99	Nil.	Tr.	Tr.	Tr.	—	—	Tr.	—	—	—	—	—	—
Zinc (Crown Brand) ..	98.58	0.03	1.13	0.14	Tr.	—	—	0.12	—	—	—	—	—	—
Copper (Wallaroo Brand)	—	99.81	Tr.	Tr.	—	—	—	—	0.19	—	—	Nil.	—	—
Aluminium	—	Tr.	—	0.40	0.09	99.51	—	—	—	—	—	—	—	—
Tin	Nil.	Nil.	0.20	Nil.	—	Nil.	99.7	—	—	—	—	—	0.10	—
Ferro-zinc	94.10	0.29	1.16	4.45	—	—	—	—	—	—	—	—	—	—
Ferro-copper	—	90.00	—	10.00	—	—	—	—	—	—	—	—	—	—
Copper-manganese ..	—	72.73	0.09	2.36	0.30	—	—	—	—	0.03	—	—	—	24.35
Cupro-nickel	—	92.58	—	Tr.	—	—	—	—	—	—	—	7.42	—	—
Cupro-cobalt	—	90.00	—	0.20	—	—	—	—	—	—	9.76	0.04	—	—

TABLE I.A.—*Physical Properties of Pure Brass.*

Composition. Cu.	Zn.	Condition.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent. on 2 in.	R.A. Per cent.	Alternating Impact No.	Brinell hardness No.	Scleroscope hardness No.
70	30	As cast	6.50	16.70	58.00	57.00	79	55	15
		As forged and annealed	8.00	21.50	68.00	65.00	85	57	15
59	41	As cast	8.80	24.90	45.00	49.70	79	90	14
		As forged	9.00	26.00	47.00	62.00	87	90	14
		Forged and annealed, 650° C. for 1 hr. ..	7.00	24.00	49.00	55.00	—	79	12
53.3	46.7	As cast	9.00	29.70	24.00	21.50	34	108	18
		As forged	9.70	32.80	28.00	30.60	49	114	18
		Forged and annealed, 650° C. for 1 hr. ..	7.50	29.10	22.50	31.60	—	108	18
51.2	48.8	As cast	7.20	26.90	19.00	21.50	27	108	18
		As forged	9.20	33.40	37.00	33.50	36	114	18
		Forged and annealed, 650° C. for 1 hr. ..	5.30	29.00	25.00	27.00	—	108	18
50.19	49.81	As cast	6.00	8.80	1.00	1.50	1	108	18
		As forged	2.30	15.80	5.00	5.50	9	117	19

reduced to 0.45 in., and re-annealed so as to restore to its original "cast" Brinell hardness number before testing.

Dynamic Stress Tests.—Both alternating and single-blow impact tests were made where possible. In the former the test-piece used was 4 in. × ½ in. × ½ in. with a 1/16 in. radius groove milled in the centre of one face, at right angles to the principal axis. A steel tup having a total weight of 10 lbs. was allowed to fall from a height of 18½ in. on to the test-piece, the first blow being given on the face opposite to the groove, and, for every succeeding blow, the test-piece rotated through an angle of 180 deg. The blows were delivered at a regular rate of 25 per min., and that number taken to break completely the test-piece, was recorded as the alternating impact number. The single-blow impact test was made in the Izod machine, using the standard 10 m/m square test-piece, notched 2 m/m deep at an angle of 45 deg. and the striking hammer contacting the test-piece at a distance of 22 m/m above the bottom of the notch.

(To be continued.)

Belgian Competition in South Africa.—The Belgian Vice-Consul in Johannesburg has written a memorandum showing how trade between Belgium and the South African Union could be developed.

Proposed Iron Foundry at Bloemfontein.—The Inspector of White Labour at Bloemfontein reports that the Carron Company, of Falkirk, through its Johannesburg representative, have applied to the Bloemfontein Municipality for 10 acres of ground on the Industrial Development Sites, for the purpose of establishing an iron foundry. The Company propose to spend £20,000 on buildings.

About two-thirds of Part 4 are devoted to the iron ores of the Indian Empire; the compilation of this section has been supervised by two members of the Geological Survey of India. The rest of this Part deals with the ores of (1) Ceylon; (2) Malay States; (3) Borneo, Brunei, and Sarawak; (4) Hongkong; (5) Mesopotamia; and (6) Palestine. Iron ores are fairly widely distributed in Ceylon, but they do not appear to be of any commercial importance at present. Extensive ferruginous deposits occur throughout the Straits Settlements and the Federated Malay States. Important deposits of limonite are found in North Borneo, and iron ores are widely distributed in Sarawak. More or less important ore bodies are to be found in the other territories dealt with in the volume.

With regard to Part 5, the section dealing with Australia is based on a Special Report in 1920 to the Imperial Mineral Resources Bureau through the Australian Metal Exchange and various official publications issued by the Governments of the various States. The actual iron-ore reserves of the Commonwealth are estimated at close upon 345,000,000 tons, and are described in great detail in the present volume. Tasmania is dealt with under Australia, but the New Zealand ores form a separate section based on a Special Report in 1920 to the Bureau through the Prime Minister of the Dominion.

THE offices of the Industrial Fatigue Research Board are now at 15, York Buildings, Adelphi, London, W.C.2.

* "Iron Ore." Part 3 (British America); Part 4 (British Asia), and Part 5 (Australia and New Zealand). H.M. Stationery Office. (Price of all three parts, 10s. net.) Part 1 (United Kingdom) was noticed in our issue for July 7 and Part 2 (British Africa) summarised in our issue for June 30.

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.*

By Enrique Touceda (Albany, New York).

The author of this Paper would assure you that he feels highly flattered in having received your kind invitation to prepare an exchange Paper to be read before your body at this meeting, and deeply grateful as well in having been asked to appear in person as your guest. He has read with great interest and profit many of the valuable contributions written by your countrymen that have served to so greatly enrich the literature of the metallurgy and metallography of iron and steel, and he well remembers particularly during the early days of his career how profoundly he prized and was impressed by Sir Lowthian Bell's classic, "The Manufacture of Iron and Steel," which at that time he continually read and studied with indefatigable zeal and enjoyment. It served as a constant source of inspiration, and for it the author has an affection that has in no way been tempered with the passage of time. The author's one regret is that, having received so much from you, he has so little to offer in return. In the letters received from the Secretary of the Conference Committee, and the Secretary-Treasurer of the American Foundrymen's Association, Mr. C. E. Hoyt, it was requested that the subject of the Paper cover the manufacture of malleable cast iron as conducted in the States. Their suggestion was naturally prompted in large part by the knowledge that the author has had a very close association with this industry, particularly during the past ten years, and in part perhaps by sharing in the interest that has suddenly awakened in other countries in regard to this subject. During the past year inquiries pertaining to the practical details of this process have been received from France, Belgium, Italy, Australia, and Japan. The author has had the pleasure of receiving visits from a number of engineers from abroad who have seemed greatly interested in the practical rather than the metallurgical details of this industry. These facts have been entered into principally, because it is the author's thought that if he took as a guide the character of these inquiries and the various questions that have been asked him by the visitors referred to, he would not miss by much the ground that members would prefer to see covered, rather than attempt to enter into an academic discussion in regard to the mechanism of graphitisation and other controversial matter concerning which so much has been written of late, or in dwelling on other strictly metallurgical details that have been so ably covered by many others, and particularly by Mr. H. A. Schwartz, whose book, compiled from articles he has written for The Iron Trade Review, is about to be issued. The author is assuming therefore that for the most part it is the purely practical end of the proposition that will prove of greatest interest to you; that what you desire mainly is a more or less brief reference to those points concerning which inquiry has been made both in the lay-out and operation of a malleable-iron plant of average capacity, and supplement this with some other matters that in some cases has not been touched upon by others.

The Lay-out of a Malleable Plant.

Starting with the lay-out of the plant, the details of which should have most serious consideration, it is obvious that its correct plan will be dependent upon the plant-capacity specified, and the shape of the building site. In connection with the latter high ground should be selected, if possible, while low ground that is naturally wet and cannot be successfully drained should be shunned as worthless, for if annealing ovens are erected in such a locality annealing difficulties will prove to be perpetual. Whether the plant is to consist of one or various working units, and even if the raw materials are to be handled by means of a crane, it is desirable that each kind be stored as near to the metallurgical apparatus in which it is to be used as is both convenient and possible. It is advisable that at the sidings where the raw materials are to be discharged, the tracks be elevated on trestles of a height and length that will admit of the rapid and cheap discharge of car contents.

In the case of the moulding, face and core-sand, a saving will result if the roof of the buildings in which they are to be stored is flush with the tracks on the trestle, in order that the cars can be discharged directly through roof openings into the building or sheds, which should be constructed with this end in view. Irrespective of the size of the plant, the various departments in each unit should bear such a relation to each other that the product from the very start of operations and at each step in the process should be continuously approaching the shipping room in the most direct manner possible, in order to avoid the retracing of steps. Economy in construction will result if each separate department is dimensioned strictly on the basis of providing not much room in excess of that which will occasion quite serious congestion when running at maximum capacity. Experience has convinced the author that, in rare instances only, are malleable-iron plants ever run at maximum capacity, for when business is booming labour is scarce and inefficient, and when labour is plenty and men are willing to do a fair day's work there is a dearth of business. A little crowding therefore in the various departments can be tolerated at times that prove exceptional. The one-storey straight-line plant of fair capacity (25 to 35 tons of castings per day) with core room and shipping rooms at extreme ends, and foundry, hard-iron mills, trimming room, grinding and sand-blast room, annealing room, and soft mills in between and located in the order named, will be found convenient, and can be arranged as to permit of considerable economy in construction, while admitting of considerable flexibility as to expansion. The character of building unit, very popular at the present time in the States, is the one-storey steel-skeleton type with curtain walls, brick pilasters, and concrete foundations, with either a saw-tooth roof, or one of usual construction with sufficient pitch, and 30 ft. wide, a monitor running the full length of the building with window sashes hinged at the top to swing inward, and sashes in the curtain wall pivoted at the centre, the roof covering being of slate, slag, fabricated cement-asbestos tile, or other fireproof material. The one-storey building of this type with either style roof possesses many advantages, in that maximum visibility within is assured, ventilation is facilitated, and fire risk minimised.

Ventilation.

One of the most important items to be considered is that of efficient ventilation, particularly in the foundry building and core room. Without a constant supply of fresh air, energy of body and alertness of mind are gradually deadened as the day progresses, and when activity and vigour are lowered the effect is always noticeable in increased foundry loss on late heats, while the hazard, due to accident, is augmented.

For effective ventilation dependence should not be placed wholly upon the monitor, but it should be supplemented by well-designed ventilators, positioned in such a manner that a steady discharge of air is assured. A popular and very efficient make rotates on ball bearings—the direction and extent of rotation being controlled by a vane—with the result that the exit for used air always faces away from the wind, which, in passing, creates an active suction. These ventilators, when installed by those who understand the ventilating problem, have proved to be worth many times their cost.

* This Paper was the American Foundrymen's Exchange Paper read before the Birmingham Conference of the Institution of British Foundrymen.

Heating.

The efficient and uniform heating of the foundry proper is a problem replete with difficulty, owing to the variable conditions that must be met. During the night there is the natural fall in temperature, coupled with the condition brought about by the wetting and cutting of the sand, that produces a clammy dampness rather hard to remove by the time the men report for work in the morning. In contrast to this condition is the state of affairs that exist after a heat, when the air is filled with hot steam and a great amount of heat is radiating from the stripped castings. Some foundries of even fair size still use the salamander, which while very cheap to install is expensive to run, takes up space of value, interferes somewhat with crane service, and occasions loss of time due to the men congregating around it if they feel slightly cold. One of the best and most approved systems is to force warm air into the building through pipes properly spaced to yield uniform heating by one of the many blower systems now on the market. Live and exhaust steam from the power house or from a separate steam source designed for heating only, or from such a plant supplemented by steam from waste-heat boilers, is used in some plants in manifolds hung in such a manner as to be out of the way but as near as practical to leakages of cold air from windows, entrances, etc., in order to heat this air as it filters into the building. The author has seen many plants where a waste-heat boiler-installation has proved to be a mistake. A waste-heat boiler has not been designed to date in such a manner that after furnace operations have ceased it can be hand-fired economically. In running but one heat per day, any saving would be offset by the huge amount of coal required to keep up steam for the balance of the time, when power or heat was required, while if the boiler is allowed to cool off and electric power and steam for heating derived from a small auxiliary heating plant substituted, the maintenance cost, due to the strains set up, would prove disastrous. The scheme works out very nicely in other cases, especially where the cost of electric power or coal is high; where two heats per day are run from the same furnace; where one boiler is used in common with two furnaces, and particularly when a great amount of power is required for sand-blasting purposes. Reference should be given to that type of boiler least affected by quick changes in temperature.

Foundry Floor.

The foundry floor is another item that is deserving of some thought. Some favour the concrete floor, but the writer believes that if a vote were taken of the moulders the decision would be in favour of almost any other type. The concrete floor is unquestionably hard on the feet, and dangerous in some particulars. When spills occur an eye can be lost or serious burns sustained due to the instantaneous generation of steam from the moisture on the floor surface, which invariably is more or less wet. Serious accidents have occurred in the carrying of iron through the moulder slipping on the rounded particles of metal that have been occasioned by spills. Even when the floor has been properly laid, it subsequently can be ruined through carelessness on the part of the moulder in shaking out the castings too hot. However, the worst feature of the concrete floor is its great tendency to transmit vibration. When bumpers or vibrators are used, the probability of shaking down dirt from the cope or the cope itself is great. A floor of hard-wood blocks properly laid on a sand foundation yields better all-round service, and is equally good for the gangways or, if protected with a little packing where the pots are dumped, for the annealing room; but when used in the annealing room a strip paralleling the front of the oven and 6 ft. wide should consist of square annealed iron plate about 18 in. by 18 in., with lugs on the under side, and set in concrete, or smooth granite block, set in concrete and well grouted. Molten iron has no other effect on wood block than to produce a surface char, which defects are very shallow, and when present become filled and well protected by sand. Black-gum, maple, beech, southern yellow pine, if well creosoted, give splendid wear. The blocks should be laid in straight parallel courses, with the grain of the wood vertical, care being taken to keep straight courses and close joints. All courses should break joints alternately by a lap of at least 2 in., and filled with a hot, low-melting-point pitch of a consistency that will flow like water, to the end that all crevices will be completely filled. Against the sides of the building and around all foundations expansion joints should be made by placing a 1-in. by 4-in. tapered board on edge against the sides of the building and around foundations, which boards subsequently should be removed after the blocks are laid and rolled in order that the void can be filled with hot asphalt to within $\frac{1}{4}$ in. of the wearing surface of the floor. The dirt, or clay, foundry floor is the safest, and the one that is most popular with the moulder. It is comparatively inexpensive, and, if given proper attention, can be kept level and in excellent condition, while if a standard travelling sand-cutter is used, there will be no danger of the floor being out, provided precaution is taken to see that the treads of the wheels are made sufficiently wide to prevent their sinking into the ground.

Sand Cutting.

The author believes that if the moulder was asked what constitutes at the present time his hardest and most exacting task, if casting surface is a vital proposition, he would state, "cutting sand." In this country it is getting increasingly difficult to employ moulders owing to the all-round disagreeable nature of the work and the conditions under which the work is done, coupled with the fact that an equal wage can be earned in other occupations where the work is much less arduous as well as much cleaner. It is very noticeable after a lengthy shut-down that in general those moulders who have secured jobs in other lines refuse to return to the foundry on the resumption of operations. The fact is being recognised that something must be done to lighten greatly his labour and make his living conditions within the plant square as far as possible, both in wage and comfort, with what obtains in the case of other industries, or, failing which, a very high premium will have to be paid to secure such labour. That the standard type of travelling sand-cutter has not been more generally used is due to the fact that moulding conditions in the malleable-iron foundry are different from those existing in foundries where other types of castings are made. As in malleable-iron practice, there are usually moulds on the floor between heats, it has been found impracticable in most instances to run the machine from pile to pile owing to the very short time available and the confusion that would result if this was attempted. In order to overcome this difficulty, a cutting machine has been devised to operate as a unit with a mono-rail hoist, to which it is attached by two hoisting cables, and by means of which it can be lifted to clear the ground. It also differs from others in that the operator rides on the machine, where he can easily control the cutting, piling, and traversing. Through this arrangement the operator can raise the entire outfit, himself included, and hop the machine from floor to floor without in any way disturbing the line of moulds already in place and located to one side of the pile to be cut, or encroaching in any way on the gangway space or interfering with the progress of other operations.

Lighting.

It would be difficult to over-estimate the importance of providing the foundry and other departments with proper and effective natural and artificial light. If the roof is of the saw-tooth type, the longitudinal axis of the building preferably should point to the north, while if the roof is provided with a monitor, the longitudinal axis of the building preferably should lay east and west. Not only should there be plenty of window space, but equally important means should be taken to secure a maximum amount of light from the space available. It is often found to be the case that considerable money will have been spent for the securing of ample window light, and this nullified in large part through subsequent neglect. Ribbed glass will transmit much more light per unit of area than will plain glass, while it will lessen, though at certain distances not wholly prevent, glare. It is perhaps slightly more difficult to keep

clean than plain glass, but if given systematic and intelligent attention, no trouble will be experienced in this direction.

If accumulations of dirt are allowed to remain on glass of any kind for undue lengths of time the surface will become pitted and eventually more or less opaque. The matter of artificial lighting is one that, to be handled correctly, should be placed in the hands of an expert. In this country the problem is simplified by reason of the fact that all one has to do is to avail oneself of the opportunity offered by the General Electric Company, who, upon receipt of plans of buildings and working conditions within, will advise, free of cost, the most suitable installation. While the New York State Industrial Commission have rules relating to the artificial lighting of factories, these cannot be accepted as a guide, as their requirements fall short of what is recognised as being really proper and efficient illumination for the particular character of work covered in their specification. They have had in mind, for the most part, the safeguarding against accident rather than a scientific consideration of the illuminating problem. The General Electric illuminating engineers, depending upon the character of work to be done, recommend from 3 to 6 foot-candles, corresponding to a power requirement of 0.5 to 1.0 watt per sq. ft. of floor area, which is more than double that required by the State. The dominant object to be attained is the securing of uniformly diffused light free from flicker, and in which both shadow and glare will be reduced to the minimum. In the higher bays a more concentrated distribution of light is desirable, and should obtain, than in the lower bays. These should be located at a height above the crane carriage, in the event that a crane is used, such as will admit of their being relamped and cleaned from it. The equipment that has given general satisfaction in this country for industrial lighting is that which is known as the R.L.M. standard dome reflector, bowl-enamelled incandescent-lamp, but a study of local conditions and building design and interior surface is essential in order to obtain the most efficient location and combination of overhead suspended and wall-bracket suspended units. All lights should be arranged as for quick re-lamping and cleaning, and for economic reasons too much attention cannot be given to the latter, and for the same reason the units should be so controlled that as few or as many lights can be turned on as are required at any time.

Handling Materials.

The following hints may prove of some value in the layout of a straight line foundry of medium capacity. A mono-rail crane so located that it passes from end to end of the foundry building and directly over two air furnaces symmetrically distanced as to moulding space and set crosswise of the building, in combination with an electrically-driven 2- or 3-ton transfer bridge of 30 to 40 ft. span that will admit of easy and rapid exit out of and entrance into the foundry, will pay for itself within a reasonable period. Through the latter arrangement the air-furnace charges can be placed on the floor space beneath the bridge at its entrance to the building, to be subsequently taken to the furnaces as needed. Such a scheme yields fairly complete crane service to both yard and foundry, while for a slight additional expenditure the mono-rail can be extended to the other departments if, as should be the case, a uniform overhead clearance of at least 15 ft. has been provided throughout the entire building unit. While the shortcomings of the mono-rail crane are due to its lack of flexibility in that the carriage is confined to one track, still, through appropriate special contrivances, it can be used to handle material surprisingly distant from its line of travel.

If it is deemed expedient to have a waste-heat boiler, the two air-furnaces can be placed in the middle of the foundry about 20 ft. between centres, their longitudinal axes lengthwise with the building and in the path of the transfer bridge, in order that they can, through this arrangement, be charged directly by it. One waste-heat boiler and stack can then be used in common by the two furnaces. In this design, however, the mono-rail can conveniently cover but one-half the length of the foundry building owing to interference occasioned by the boiler and stack.

In one type of mono-rail a novel feature consists in the ability of the operator to raise or lower himself through means of a telescopical arrangement. The cables connecting the controllers for the various motors all are arranged with a flexible connection in order that at all times the operator has control of the travel and hoist motor and the motor for hoisting himself.

Through this arrangement it is possible for the operator to pick up any character of load in the yard without the aid of an assistant and bring it into the foundry, or, if in the foundry, do much work that otherwise would require the use of an additional man. In larger foundry units, it will be found that a more ambitious system of crane service not only should be adopted, but is demanded by conditions. The travelling-bridge crane service for the malleable-iron founlry differs in the majority of cases from what should obtain in the case of the grey-iron foundry, for it is rarely used for drawing patterns or for handling finished moulds. In some malleable-iron foundries, however, such as those making heavy railway work, while the requirements are quite similar, it is for a different reason. The large bottom-pouring ladle is now being quite generally and successfully used for the pouring of moulds for this class of work. The latter and former condition call for a creeping speed of from 1 to 5 ft. per min. Pouring metal through a nozzle from a large ladle suspended from a crane and passing from mould to mould necessitates quite careful control of the speeds. Consequently, the creeping and hook speed particularly should be adapted to the character of work to be done. In the absence of a specific design of building, it is not possible to indicate the best arrangement of travelling crane and supplemental crane installation. Such details are familiar to the structural engineer, and are not as serious as those to which reference has been made, if to these be added the fact that any crane should have a positive system of mechanical brakes, have electrical equipment as simple as possible, and so constructed as to prevent the admission of dust or dirt.

While, some few years ago, direct-current for crane service had numerous advantages over alternating current, electrical-control equipment has been developed to such an extent that either D.C. or A.C. current can be used with satisfactory results on slow speed. In the case of D.C. current, dynamic-braking is used for lowering, and with A.C. current regenerative-braking with solenoid load-brakes for creeping-speeds are used.

Lifting Magnets.

The lifting-magnet, used in connection with the crane, in the writer's opinion, is an indispensable accessory when the present labour situation is considered. Those who have seen labour sweat and toil in hooking-out hot castings from steaming sand, need not be told that this constitutes a very disagreeable task, and one, for reasons already cited, the men should be relieved of. Aside from this, when the castings are hooked-out and piled, much burnt sand is left in a heap on each floor that subsequently must be collected from all the floors in use. By means of the magnet not only can the castings be quickly removed, but the core wires, the cores themselves for the most part, and the chills are removed at the same time, and the entire mass deposited at one, or a few convenient places, from which the burnt sand can be easily and quickly taken to the dump, and the wire and chills recovered. Also, much time can be saved the moulder, particularly in the rapidity with which the sand cutter can get to work. It is needless to dwell on the many other uses to which the magnet can be put; in quickly loading the castings on to the trucks, that are pushed by hand, handled by the shop-mule or tractor, as the case may be, to the hard-iron mills, while its use for handling of pig and scrap is obvious.

In the event that the plot of ground is somewhat square, a rather convenient layout of building is in the shape of a very deep channel, one leg consisting of the foundry building, mainly, say, 300 ft. long by 136 ft. wide (1,300 to 1,500 sq. ft. of moulding space per ton of castings, the sq. ft. depending upon whether the work is heavy or light), the other leg containing, for the most part, the annealing room, say, 300 ft. long by 95 ft.

wide, while the web, a building 300 ft. long and 50 ft. wide, connecting and opening into the two buildings that form the legs of the channel. The situation can be easily understood by reference to the arrangement of the departments as given for the straight line plant by simply considering that the straight line is bent in the form of a channel, the various departments following in the same order as in that construction. Through this design there would be a court about 70 ft. wide to provide light and ventilation, and in which a wash room can be built, easy of entrance from any of the main buildings.

Large Plants.

For a somewhat larger plant with more furnaces, where the shape of the plot approximates the letter "T," the entire foundry building can be built like a rather shallow, short-legged, long-webbed channel, the annealing room and other departments being contained in a building in the centre of the court at right angles to and opening into the web and extending considerably beyond it, thus giving the buildings as a whole the shape of the letter "T." The foregoing layouts are simply cited as cases that have proved to be convenient in operation and flexible for either low or maximum production.

Both the hard and soft mills should be so installed that they easily can be filled by hand or power, and high enough to clear a truck if placed directly under them to receive their contents.

Black-Heart Malleable Iron.

A description of the black-heart malleable-iron process has appeared in so many papers that have been written within the past few years that the author feels certain members must all be very familiar with it. On this account a very brief explanation only will be given. The castings, as cast, whether made in the cupola, air-furnace, open-hearth or electric-furnace, must not only consist of white iron in which no trace of primary graphite exists, but in order that the finished product, after heat-treatment, be of normal fracture and superior in mechanical properties its composition must lie between certain definite limits. The white-iron composition that the author would recommend for best all-round conditions, embodying facility of conversion, fluidity, shrink, static and dynamic strength, and ductility in final product, is of necessity and for obvious reasons a compromise. Such a composition is:—Silicon, 0.90; phosphorus, 0.20; sulphur, 0.060; manganese, 0.25; and comb. carbon, 2.35 per cent.

Later, some remarks will be made concerning permissible limits, but while at this point, the author desires to explain that the recommendations he will give in regard to both melting and conversion are based upon works conditions and not upon what can be accomplished by a scientist in laboratory apparatus of easy and positive control. In the States the cupola is little used except for castings for fittings. Melting the charge in the presence of coke in the ordinary cupola means not only high-sulphur but high-carbon. The mixture is one in which sprue and malleable scrap predominate; some steel may be used, and enough pig added to bring the silicon to the required point. The mixture as it enters the cupola will run from 0.70 to 0.95 per cent. silicon; the total carbon from 2.50 to 2.75 per cent.; the manganese in the neighbourhood of 1.00 per cent., the phosphorus under 0.18 per cent. The loss in silicon is but little, rarely as much as 0.12 actual, the loss in manganese about 2/5 the original content; carbon will be picked up to an amount that will produce an average of 3.00 per cent. in the product, while the amount of sulphur in the product will be a function of the fuel ratio, the quality of the coke, the amount in the original mixture and the size of the scrap. The smaller the scrap the larger will be the gain in sulphur. In the fittings examined by the author the sulphur will average around 0.25 per cent. While such iron, when annealed at a high temperature, will produce a free-cutting product, and while it is acceptable as a material for fittings, it would show a very abnormal structure in sections at all heavy, while it would be very low in elongation.

(To be continued.)

Publications Received.

Kelly's Directory of the Merchants, Manufacturers and Shippers of the World. Published by Messrs. Kelly's Directories, Limited, 186, Strand, London, W.C.2. Price of the two volumes 64s., post free.

This is the thirty-sixth annual edition of Kelly's Directory, and its two volumes contain some 5,000 pages and relates to no less than 20,000 foreign and colonial cities and towns, under which over 1,000,000 trade descriptions are given.

The directory is in two main sections, the first dealing with foreign countries and the second with the British Commonwealth. Under each town-heading, classified and alphabetically arranged lists are given of all engaged in trade, together with the class of goods in which they deal. The index and instructions for using the directory are given in four languages—English, French, Spanish, and German. The maps, brought up to date, of all the principal countries have been retained.

The Metal Industry Handbook and Directory. Published by Louis Cassier Company, Limited, 34, Bedford Street, London, W.C.2.

This year's edition differs materially from previous editions by the incorporation of a ferrous section. This new portion comprises tables of weights for various shapes and sizes of cast iron, wrought iron, and steel, standard specifications for steel, Admiralty and aircraft specifications. The load equivalents in British and metric measurements ranges from 19.6 to 42.5 tons.

Staveley Coal & Iron Company, Limited, Chesterfield. Monthly stock lists of cast-iron pipe for July.

Messrs. Automatic & Electric Furnaces, Limited, 281, and 283, Gray's Inn Road, London, W.C.2.—Catalogue dealing with Weld-Barfield Automatic Electric Hardening Equipments.

Industrial Welfare Society, 51, Palace Street, London, S.W.1.—"The Human Factor in Industry," by Robert R. Hyde.

Book Review.

All Electric Age, by Adam Gowans Whyte, B.Sc. Published by Messrs. Constable & Company, Limited, 10, Orange Street, Leicester Square, London, W.C.2. Price 7s. 6d.

This book is of a popular character and is designed to place electricity in its proper degree of importance in the eyes of the layman. No mathematics are given nor is the matter treated at all from a text-book standpoint.

The book is divided into fourteen chapters and is well illustrated and indexed. For the layman, the book will open up an important vista, which under modern conditions of industry should be realised by everybody.

Canada and European Imports.—A cable from Ottawa states that an announcement has been made regarding the operation of the new Depreciated Currency Law, designed to prevent dumping, which provides that the value for duty shall not be less than the value of similar goods produced in the United Kingdom, and that if similar goods are not produced in the United Kingdom, the value for duty shall not be less than the value of similar goods imported from any European country in which the currency is not substantially depreciated. According to Departmental instructions issued to collectors of Customs, the new order will apply to goods from Germany, Austria, Hungary, Yugo-Slavia, and Russia

British Association.—The arrangements for the autumn meeting of the British Association, which begins at Hull on September 6, are now well advanced. Sir Charles Sherrington will be the President for the year. He is also the President of the Royal Society. The Association is making a special effort this year to secure an increased attendance of the younger scientific students at the meeting. Part of the income from the £10,000 of War Stock lately presented to the Association is to be used for this purpose, and a certain number of British Association Exhibitions have been offered to the Universities and University Colleges, the Senates being asked to nominate students not higher than the B.Sc. degree. The Exhibition will give the student his travelling expenses and his membership.

The Training of Foundrymen.*

By A. A. Liardet.

Modern Conditions.

It is an indisputable fact that at the present moment the very greatest difficulty is experienced in finding boys willing to be apprenticed to the art of moulding.

If this state of things continues—Necessity being the mother of invention—moulding will cease to be an art, and will degenerate into a mere mechanical process, carried out by workers depending on the brains of the pattern-maker and the mechanic.

The average boy is almost invariably interested in all things mechanical, but is rarely attracted by the outwardly drab occupation of playing with dirty sand, which is how the moulder's occupation is looked upon by the outsider, all ignorant of the skill and experience necessary to become a proficient foundryman.

This being the case, it becomes almost the foremost duty of an organisation such as the Institution of British Foundrymen to consider, and, if possible, recommend for adoption, means by which foundry work and its various branches can be made more attractive to the average boy just ready to leave school.

We should go a long way towards accomplishing this if we could adopt in our foundries in conjunction with the local Technical Institutions, a system of training which would afford equal facilities to every class of boy entering a foundry, to attain before the completion of his actual apprenticeship—by his own exertions and proficiency—a knowledge of the higher branches of foundry work, such as metallurgy and the selection of materials.

Co-operation of Technical Schools.

In the past, technical schools have not catered for the training of the foundryman, but of more recent years several of the larger establishments have been running a course in this branch of engineering, and it is now the wish and intention of the Bradford Technical College to inaugurate such a course in conjunction with the foundries of the district.

When considering the question of any sort of training the first point to make clear in one's mind is the final result we wish to achieve. What is the object of the training? What are we aiming at to produce?

The Raw Material.

Training is a process of evolution, the shaping of raw material into some desired finished product, by means of carefully planned out progressive steps, very similar to any process of manufacture from the raw material to the finished article.

The materials upon which we have to work in this case are human beings—material sometimes presumed to be of a standard specification, but when subjected to analysis, of widely varying qualities, both physical and mental.

Any scheme therefore, which we may suggest, while keeping the ultimate desired result always in view, must provide for dropping unsuitable material into its proper grade, after having given it repeated opportunity to take the polish necessary for the next step in the evolution of the desired finished article.

It is useless to continue work on material, when that material is incapable of taking the preliminary polish.

Our system therefore, must also include an examination of this material, at a very early period of its evolution, to avoid the danger of throwing on to the scrap heap material which might have been suitable for some other purpose, but rendered useless owing to the fruitless work that has been done upon it.

Having determined these points as axioms in the problem of the Training of Foundrymen, our next task is to decide on the final result we wish to achieve, and the various gradings into which we shall have ultimately to consign our raw material, according to its capabilities of absorbing the training we are going to impart to it.

The diagram indicates the author's idea of the grading of the finished product, together with suggestions for the necessary training to produce it.

Doubtlessly many will recognise a similarity between this diagram and one that was published by the Engineers' Advisory Committee to the Bradford Technical College for the training of civil, electrical and mechanical engineers. This latter scheme has been adopted in a modified form, by most of the engineering shops in Bradford, and the experience gained from its adoption enables me to put forward this present scheme avoiding many of the difficulties which arose with the original.

Probationary Period.

Adopting the principle of grading, or more correctly, selection, we start by bringing a boy into the foundry between the ages of fourteen and sixteen, telling him that he is on probation until he reaches the age of sixteen, that until then, he will only be called upon to do light work, will have every opportunity of making himself familiar with foundry work, learning the routine, and observing the conditions under which the foundryman spends the greater part of his day. We further tell him that at the age of sixteen he will have to pass a simple test examination in mathematics, engineering science, and engineering drawing, which he must study at the branch schools evening classes.

We also make it quite clear that he is under no obligation to enter on a trade apprenticeship, nor do we bind ourselves to take him as an apprentice if he is not fit physically or otherwise, to follow the calling of a foundryman.

Here we have our preliminary grading or selection. If a boy fails to show a sufficient knowledge of the elementary subjects mentioned above, or is unsuitable for foundry work, he has to choose some other trade. At the early age of sixteen no harm is done, he still has ample time to take up and learn some other subject.

Ability to Read Drawings Essential.

At this point the author cannot emphasise too strongly the absolute necessity for all foundrymen to have some knowledge of engineering principles. How many otherwise most excellent foundrymen of to-day are hampered by their inability to read a drawing? How often does it happen that it is only when the pattern is in the foundry, or worse still, when the casting is made, that the foundryman can point out obvious errors in design leading to cracked or drawn castings.

On many occasions since the formation of this Branch has the opinion been expressed, that half of the foundry wasters are made in the drawing office. This is only too true, and implies a lack of co-operation between the designer and the foundryman, or more often, because the foundryman has not thoroughly understood the drawing when it was shown him.

It is for this reason that it is desirable to include a knowledge of engineering drawing, or at any rate an ability to read simple drawings, as a necessary qualification of the would-be foundry apprentice, and advocate continued instruction in this subject during at least the first two years of apprenticeship.

Trade Apprenticeship.

This preliminary grading having demonstrated that the boy is satisfactory, he commences his Trade Apprenticeship approximately at the age of sixteen.

Nothing definite can be said at the moment on the advantages or disadvantages of apprentice indentures, or what is often termed the binding of apprentices. It is only reasonable that if employers agree to give facilities to boys to take such a course of training as is laid down here, they should ask for some form of assurance that the young man will not run away before they have obtained any real benefit from his services, as soon as an opportunity presents itself for him to improve his position.

On the other hand, if the training is attractive enough and the youth really in earnest, no such temptation should ever arise.

* Paper given before the West Riding of Yorkshire Branch of the Institution of British Foundrymen.

From 16 to 17 the practical work in the foundry would consist of light sand core-making, and light bench moulding.

In many foundries it is the custom to put the apprentice with one or more experienced moulders as a helper, often working on heavy and intricate moulds. This appears to me a case of trying to make him run before he can walk.

During the probationary period he will have had sufficient opportunity to learn the root principles and methods of moulding, so that when given a small pattern or core box he should know, at least, what he is expected to produce from it.

Every foundry foreman should select one of his assistants, either an under-foreman or charge hand, whose especial care it should be to generally supervise the work of all apprentices. In large foundries, where many apprentices are employed, it would be quite reasonable to appoint a thoroughly skilled practical moulder whose sole duty would be the supervision of apprentices' work.

The art of founding is one of the most ancient. Its secrets and mysteries have been handed down from generation to generation. In a constructive art of such antiquity there must of necessity exist many traditions—not only many traditions, but many conflicting traditions. The present-day student of the art is likely therefore, if not supervised by one selected workman, to be at the mercy of many conflicting and erroneous traditions, gathered from the many instructors with whom he would otherwise come into contact.

Naturally, the discipline of the foundry would have to be maintained, and any such supervisor would not control what the apprentice should do, but only how he should do it.

During this period the technical training would consist of mathematics, engineering drawing and chemistry. By mathematics it is not intended to convey that instruction would be given in analytical or geometrical conics, integral calculus and all the other advanced subjects covered by this term, but rather plain applied arithmetic, simple algebra and geometry, all to enable the student to understand engineering drawing and the simple calculations entailed in chemistry. The statement is advisedly made that this instruction should be taken at evening classes (or on one half-day per week), because at this juncture it would be going too far in saying that we recommend day classes without having consulted employers on their views on the subject.

Day Classes Preferable.

It should be stated, however, that the day class is more satisfactory in every respect. Not only has the employer a definite control over the attendances, as he can insist on the apprentice attending, and call for reports of his work, which he cannot do in the case of voluntary evening classes, but also it is far more likely that the boy will derive greater benefit and learn more, from instruction given to him after only having done a few hours' manual work, than he would at the end of a full day's work.

During this period it is considered inadvisable to include any subject touching on actual foundry work, as the apprentice will have quite sufficient new ideas to absorb regarding foundry practice during the day. Chemistry only is introduced, additional to the engineering drawing and mathematics, a knowledge of which is so essential to the foundryman.

The chemistry would be of such an order as to serve as introductory teaching to metallurgy, which appears later in the course.

Practical Side the Most Important.

From the diagram it will be seen that no further definite selection takes place until the age of 19.

Age.	14 15 16	17	18	19	20	21	
Practical Training.	Boy can start any time between the ages of 14 & 16. Employed in Foundry on Light Work, handling of Patterns, with every opportunity to see Pattern Shop work. Not finally Apprenticed until age of 16.	Commences Trade Apprenticeship Moulding and Coremaking. Light Sand Core and Moulding Work.	Continuation of Trade Apprenticeship. Advanced Core Making and Moulding Work in Sand.	Continuation of Trade Apprenticeship. Heavy Sand Moulding. Loam Moulding.	HIGHER GRADE. Moulding Six months. Furnace Work. Metal and Sand Mixing. LOWER GRADE. Continuation of Trade Apprenticeship to Moulding or Coremaking.	HIGHER GRADE. Moulding Six months. Laboratory and Research Work. LOWER GRADE. Continuation of Trade Apprenticeship to Moulding or Coremaking.	Progress made in Shop Work will be taken into consideration in conjunction with result of yearly examinations for decision as to subsequent disposal.
Technical Training.	Mathematics, Engineering Science Engineering Drawing. At Branch Schools, Evening Classes. Test Examination for Fitness to enter Technical College on Apprenticeship.	Mathematics, Engineering Drawing. Chemistry. Two Nights a Week at Evening Classes, or on One Half Day per Week.	Theory of Pattern Making from Drawings. Simple Metallurgy. Chemistry. Two Nights a Week at Evening Classes or on One Half Day per Week.	The Blast Furnace Grades of Ore and Pig Iron. The Iron Foundry Cupola. Steel Making Plant. Refractory Materials. Moulding Sands. Metallurgy. Chemistry. Two Nights a Week at Evening Classes, or on One Half Day per Week.	HIGHER GRADE. Steel Making Processes. Microstructures. Annealing. Metallurgy. Equivalent one half day per week. LOWER GRADE. Continuation of Simple Course in Foundry Metallurgy and Chemistry. Equivalent One Half Day per Week.	HIGHER GRADE. Advanced Metallurgy. Heat. Treatment. Alloy Steels. Equivalent one day per week. LOWER GRADE.	Annual Examinations corresponding as near as possible to the completion of each year of Apprenticeship will be held, to decide subsequent Technical Training. Failures relegate to lower grade or, if repeated, disqualification.
	Probationary Period.	Trade.	Trade.	Trade.	Lower Grade.		RESEARCH WORK. ASSISTANT FOUNDRY MANAGER. ASSISTANT METALLURGIST. FOUNDRY CHARGE HAND. SKILLED MOULDER OR COREMAKER.
		Apprenticeship.	Apprenticeship.	Apprenticeship.	Continues Trade Apprenticeship.		

SUGGESTED SCHEME FOR THE TRAINING OF FOUNDRYMEN.

A process of automatic grading, however, is taking place. From 16 to 19 a steady progressive course is recommended, the apprentice being gradually advanced on to more important and intricate moulding, while his technical instruction carries him up to simple metallurgy with a knowledge of the various melting and refining processes.

Examinations would be held at the end of each session, and reports furnished on the progress made in the foundry.

Failures at examinations would necessitate the student continuing instruction in the subjects he has failed in, instead of progressing to the more advanced work of the next year.

This would constitute the grading, but would give boys who develop late, a chance of reinstating themselves at the next examination, and enabling them to continue with the others on the progressive course.

A second failure would naturally point out the inability of the boy to absorb technical instruction, but even this would not debar him from continuing on a lower grade course, or if he preferred, from dropping class work altogether.

Our system is such, that during the whole of this period he is learning the trade of a skilled

moulder, so that his failure in technical work, and his decision to drop it, would not prevent him from completing his trade apprenticeship.

We must not lose sight of the fact that a man may be a thoroughly competent skilled moulder with very little technical knowledge beyond that which he can learn from actual experience in the foundry, although the more instruction he receives in subjects concerned in his work, the more intelligently and satisfactorily will he accomplish it.

Knowledge of Pattern-Making Included.

The theory of pattern-making and moulding referred to in the technical training between 17 and 18, will constitute a link between the knowledge of engineering drawing already gained and the principles of pattern-making and moulding.

If a boy wishes to become a pattern-maker, he should endeavour to teach practical pattern-making and moulding. Not even a moderate degree of skill can be imparted to a student in either of these subjects in the relatively short time which is at his disposal.

If the boy wishes to become a pattern-maker, he must be apprenticed to a pattern shop and learn to make patterns; if he wishes to become a moulder then he must be apprenticed to a foundry and learn to mould. There is no need for the moulder to try to make patterns, nor for the pattern-maker to try to make moulds, but there is *every* reason for the moulder to know how patterns are made, and the pattern-maker to know how moulds are made.

This, then, must be the function of technical institutions with relation to the training of foundrymen: to impart to the student a knowledge as to how patterns should be made from engineering drawings, to show by means of actual patterns the meaning of prints, cores, loose pieces, draw-backs, turn-over boards, skeleton patterns, struck-up patterns, etc., etc., bearing in mind that there is no logical reason for a moulder to know how even to sharpen a chisel or set a plane iron.

College Foundries Criticised.

A foundry department in a technical institute for the purpose of preparing moulds and running castings is a waste of money, and no exceptions are made for those establishments running a diploma or degree course for mechanical engineering, including foundry work.

The theory of moulding, however, should be taught, the theory underlying contraction, the effect of risers, chills, the difference between dry and green sand moulding, etc., etc. A small cast-iron melting plant should be available for making test pieces from various mixtures, carrying out experiments in shrinkage and other more scientific investigations in connection with castings other than the actual making of the castings themselves.

The simple metallurgy referred to would not at this period include any practical analysis; in fact, practical analytical work is not advocated until after the age of 19, and then only to those apprentices who have qualified for the higher grade course and whose attainments appear to indicate that they are ultimately fitted for occupations in which a practical knowledge of analysis as applied to foundry work, is essential.

Lectures would be given dealing with the properties of metals, the theory of the blast furnace, grading of pig-iron, the iron foundry cupola, steel-making plant, and the alloys of copper, zinc and tin.

Necessary Apparatus Defined.

Practical work would be confined to experiments such as the reduction of ores, the examination of the physical properties of various metals and mixtures of metals, as revealed by the recognised mechanical testing appliances, and possibly a few simple laboratory experiments showing how to detect the presence of certain elements in various alloys.

At the age of 19, the most important grading or selection in the whole course takes place. It is at this point that we determine by examination the progress made by the apprentice in the shop, whether he should follow, for the last two years of his training, an advanced course which would fit him, at the expiration of his apprenticeship, for the positions of responsibility in a foundry, or continue his trade apprenticeship, with such additional technical instruction as he can absorb, ultimately becoming a skilled moulder or coremaker.

Training Raises Status.

However democratic our scheme may be, offering as it does equal opportunities to all, a few only will rise, whilst others less favoured with the necessary talents will remain on the lower level, but at a level considerably higher than they would have attained without the opportunities of gaining the knowledge and experience which such a scheme as this affords.

This last consideration is perhaps one of the most important in the whole scheme. We mislead no apprentice as to what position he will be fit for on completion of his time. We continue to instil into him the fact that he is apprenticed to the trade of a moulder or coremaker, with opportunities to rise. Even if he is not successful, the existence of these opportunities must lead him to absorb a large quantity of the instruction offered for his consumption, so that he finishes his apprenticeship as a skilled craftsman, with an intelligent knowledge of the technicalities of the materials with which he works.

The higher grade training in the works for apprentices who attain the necessary standard at the age of nineteen, would consist for the first year of furnace work and practical experience in the mixing of metals and preparing refractory materials.

In the iron foundry they should be actually employed on the cupola, in the brass foundry on the mixing and melting of the various alloys, and in the steel foundry on the furnaces and annealing stoves.

Moulding of Primary Importance.

It is suggested that for approximately six months in each of the last two years, the apprentice following the higher grade should return to moulding.

In some of the projected training schemes for foundrymen, and one of the conditions laid down by the proposers, is, that the co-operation of employers should be enlisted to find employment for the highly-trained product. This, of course, is a highly impractical suggestion. A demand for such men cannot be created.

It is for this reason that the author suggests the six-months' moulding during each of the last two years, so that in the event of the apprentice passing successfully through the higher course, but not being able to find on the completion of his apprenticeship a vacancy in a position of responsibility in a foundry to which the knowledge he has acquired fits him, he will not have lost touch with practical moulding, and can take work as a moulder until a more favourable opportunity occurs for his advancement.

Works Laboratory Practice.

The last year of practical training includes laboratory and research work. A laboratory is not found in every foundry. Where such a department exists, it is undoubtedly better for the apprentice to study practical laboratory work there than in an academic institution of a similar kind, provided that, as our scheme provides, he has had instruction in chemistry and metallurgy at an institution where it is the business to teach. The average works metallurgist is far too busy a man to afford time to instruct young men in the rudiments of chemistry. In a foundry laboratory they would learn the routine of foundry analysis and its application to practice.

Apprentices in foundries not having laboratories would perforce have to be drafted as whole-time students to a technical institution having facilities for teaching practical laboratory work, and ample opportunity afforded them for visiting the laboratories of other foundries in the district.

The technical training during the last two years would consist of theoretical work in connection with the advanced practical work referred to above. Several of the subjects are enumerated on the diagram, but they are only meant to serve as an indication of the standard of work undertaken, and by no means limit the instruction to the actual subjects mentioned.

Foundry Research Workers.

In the last year a longer weekly period for theoretical work is advocated, and in exceptional cases the desirability of liberating the young man from apprenticeship and allowing him to enter some establishment where foundry research work and metallurgy are solely carried out should be considered.

It will be noticed at the foot of the last column of the diagram a suggestion for the final grading of the finished product. The type of positions which the fully-trained young foundryman ought to be able to fill. The author realises that he will incur the criticism of many of the more scientific fraternity by recommending that the training for the foundry research worker and metallurgist should be based on an apprenticeship to foundry moulding. Possibly for pure research work and metallurgy such training is not necessary, but when these have to be applied to practice, the only way the metallurgist can learn how it should be applied is by studying the methods and operations to which he has to apply it. A knowledge of the theory of music is essential to make an accomplished pianist, but he would have no use for an instructor in this subject who could not play the piano. Abstract scientific metallurgy is of little use in a foundry.

The practical foundryman of to-day is groping in a fog—not a fog of his own making—as no one can dispute the fact that British foundries have turned out castings which are second to none in the world.

It is a fog set up by the conflicting theories and dogmas of scientific advisers, who, from the mentality developed from an abstract academic training, are unable to examine the many foundry problems with that broader outlook which a partially practical training imparts.

On the other hand, we must admit that very valuable work has been carried out by scientific research, and that practical scientific control carried out by the right type of man is an absolute essential to the successful operation of a foundry. We should regard the present relation it bears to practical problems as being in the process of evolution.

Whilst the practical foundryman is dropping many of his erroneous traditions by rubbing shoulders with scientific control, scientific control is dropping many of its unapplicable scientific investigations by rubbing shoulders with the practical foundryman.

Conclusions.

The scheme elaborated is meant to illustrate in principle only a proposal for the training of foundrymen. It is incomplete in many details.

The actual number of hours to be devoted each week to technical instruction would have to be decided by those accustomed to drawing up a syllabus of instruction. Whether this instruction should be given in the daytime or at evening classes would be a matter for the employer to decide, as also whether the apprentices should receive wages for the time spent at day classes, if these were adopted. Very little mention has been made of malleable and non-ferrous foundries, but the principle of training would remain the same.

It should be stated that those responsible for the organisation and control of this technical institution are willing and anxious to co-operate in a scheme of this kind, and are prepared to recommend the establishment of plant, laboratories, and syllabus to provide for a course of training similar to the one here laid down. Additionally, it would have the whole-hearted support of the Engineering Advisory Committee to the Bradford Technical College.

The author wishes to acknowledge his indebtedness to the Principal, Professor Richardson, and to Professor Charnock, for enabling him to state with confidence that such a course could be readily put into operation at this college provided certain additional plant and apparatus were installed.

If a recommendation for some such scheme—after it has been duly criticised—were made by local foundrymen, the attention of those able to put it into operation would be forced as to the desirability and necessity of its adoption.

What more fitting body is there than the Institution of British Foundrymen, to discuss, to decide and recommend, what is the best scheme for the training of foundrymen?

Discussion.

MR. BULLOCK, supporting the scheme, said that it would be necessary to advertise it very widely, to let boys know what training and chances they would get if they decided to learn the art of moulding. This would be necessary, as otherwise the putting into operation of such a scheme would not attract more boys to the foundry.

MR. SLINGSBY generally approved of the scheme, and emphasised the point brought out by Mr. Bullock. He had had some experience with instruction in practical founding as given at a technical institution, and knew the difficulties entailed. He was strongly opposed to any endeavour to teach practical founding in such an institute.

MR. W. H. POOLE said that although a metallurgist and engaged almost entirely on research work, he was strongly in favour of the works metallurgist receiving a partial training in the foundry. He was of the opinion that this would lead to what everyone wished for—the best type of practical scientific co-operation.

MR. SMITH, whilst generally approving the scheme, foresaw great difficulties in putting it into operation, especially in small foundries where employers depended in a large measure on the apprentices to get the output. Such foundries could not spare apprentices to attend technical classes, and had very little facilities for affording experience in any work other than the actual moulding. He strongly advocated the day class instead of the evening, as he knew the tendency for boys to go to sleep in the evening classes after a day's hard work. He was of opinion that no practical moulding should be carried out at technical institutes, boys only spent their time throwing sand at each other in such classes.

MR. WATSON, in supporting the scheme, said he had had actual experience in giving instruction in foundry practice, and knew the great benefit which apprentices derived from gaining some technical knowledge of the work they were engaged upon.

MR. PARKER thought the scheme would break down with apprentices working in highly specialised foundries, where they would have no chance to learn other moulding than the special work upon which the foundry was engaged.

MR. GROVES was of the opinion that the time suggested per week for technical instruction was far too short. There was so much to teach that one half-day or two evenings per week would be quite inadequate.

MR. THORNTON generally approved of the principle of the scheme, but thought there was so much in it that wanted careful consideration, that it ought to be printed and sent to all members and interested parties for their written criticisms.

MR. LOVE thought that one of the chief difficulties in obtaining apprentices to foundry work was the low wages paid. Parents could not afford to keep their boys at a trade, even with special opportunities for learning and advancement, if the wage they earned was so small.

MR. ROBINSON thought the chief objection to the scheme was that employers generally would not welcome it. Not only would it be a source of expense, but it would lead to disorganisation of the foundries, if boys were allowed to go to classes during working hours, and be moved to other jobs just at an age when they were really becoming useful.

The Author's Reply.

THE AUTHOR (Branch-President) replying to the various points raised in the discussion, said that he entirely agreed on the necessity of advertisement, but submitted that this would be accomplished through the branch schools. Headmasters of schools would be enlightened on the necessary qualifications for, and advantages offered to, boys who decided to learn foundry work. They would have to guide their early education to enable them to pass the preliminary qualifying examination to the Technical Institute at the age of 16. He reminded those who spoke against practical foundry teaching at a technical school that he had made it very clear in his paper that he was absolutely opposed

to it. He acknowledged the difficulties of the small foundry and the specialised foundry, saying that this had been recognised with reference to the training of engineering apprentices now in operation in Bradford. A suggestion had been made for an exchange of apprentices between different works, to enable all to obtain equal experience, but after consideration, this idea was not adopted. At the present moment he could only say that if such a scheme were adopted, these foundries would find a difficulty in obtaining apprentices, as they would naturally wish to go to those offering the best facilities for gaining an all-round experience. In replying to the difficulty of low wages paid to foundry apprentices, the President said that if we were considering a scheme for the betterment generally of foundrymen of the future, some sacrifices would have to be made. The employer, who would ultimately reap the benefit of a supply of better trained and more intelligent workmen, would have to put up with the inconveniences and expense of allowing apprentices to take up such a course, while the parents would have to be satisfied with the boy's reduced bread-winning capacity in order that their son might benefit by it in the future. He submitted that boys whose sole immediate object was to earn as much money as they could, were not likely to make efficient foundrymen. Whilst acknowledging the fact that the inauguration of such a scheme entirely depended upon the co-operation and willingness of the employers, he did not agree that there was likely to be any opposition from them. He felt sure that employers would recognise that it was about time that something should be done for foundrymen. Every employer realised the difficulty of obtaining apprentices to foundry work.

After the discussion, on the proposition of MR. ROBINSON, seconded by MR. JOHNSON, the following resolution was unanimously adopted:—

"That this general meeting of the West Riding of Yorkshire Branch of the Institution of British Foundrymen heartily approves of the scheme of training for foundrymen detailed in the paper given by the Branch President, and recommends the foundry employers in the area to give it their serious consideration as a means of ensuring a better supply of foundry apprentices and generally improving the status of the foundryman of the future."

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Apprenticeship Course.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your leader, announcing the fact that a series of articles (each forming a separate lecture) is about to be published in THE FOUNDRY TRADE JOURNAL, for the benefit of apprentices, has doubtless been read with great pleasure by all who have the interests of the foundry industry at heart, for it is a practical proposition, and deserves the enthusiastic support of all. Technical journals, whilst adequately catering for those who have already embarked upon a career, have not proved attractive to the beginner, to whom the matter, being more or less unintelligible, is devoid of interest, and a series of articles on the lines suggested will undoubtedly supply a long-felt need.

It is to be hoped that foundry managers will show appreciation by ensuring that every apprentice will have an opportunity of studying the articles, and it may be possible for a list of questions to be compiled for the purpose of subsequent examination. There is no doubt that classes held in the foundry will be productive of better results than those held outside, for in connection with the former, practical demonstrations are possible, which do more than anything else to excite interest, and so make them more comprehensible. The matter, too, need not be confined to the foundry, for in the engineering shops there are many boys who are, at the moment, engaged in "blind alley" occupations, and many of these would welcome the opportunity of learning a trade, if the proposition is put before them in an understandable and attractive form.

There is no doubt that the choice of authors is a popular one, for that they are thoroughly practical men, well versed in every phase of the founding industry, is established by their many contributions to the columns of this Journal. The FOUNDRY TRADE JOURNAL is to be congratulated upon the initiating of a movement which has for its object the welfare of the industry for which it caters, and if it receives the support it deserves, the success of the enterprise is already assured.

I am, Sir,
Yours, etc.,
H. W. J.

Steel Borings and Turnings in the Cupola.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I noticed Mr. Cameron's reference in his Paper on "Semi-Steel" to my own Paper before the B.F.A. in 1916.

In connection with the use of steel turnings and borings, I have melted many tons of these both *alone* and in mixtures in the cupola. The only serious difficulty I ever met with was that of handling this material. (See *Engineer*, Nov. 27, 1916, and Aug. 2, 1918.)

The comparative ease with which steel borings and turnings can be melted in the cupola does not appear to be generally recognised. Steel in this form offers the largest surface area per unit weight of any form of scrap, and the advantage of this feature in the cupola-melting of this material will be obvious. Very finely divided turnings or borings either throttle the blast and hang up the cupola or finish up in the spark arrestor, according to the quantity used, as would be expected. I have, of course, never been able to successfully melt this type of borings.

The difficulties attached to the making of steel-mixture irons in small quantities are well known. The best course to follow in this case is that of re-melting previously melted steel scrap in the final mixture. This method, however, has the disadvantage of increasing the cost of the final mixture. The next best method to follow in making small quantities of steel-mixture iron is to use steel scrap direct in the form of borings.

I have seen, and friends have shown me, re-melted steel borings beautifully outlined in sections of castings made from mixtures containing steel borings. These borings existing in finished castings are usually hard and frequently unmachinable.

I submit, Sir, that vigorous stirring of the molten metal in the ladle is all that is required to prevent the occurrence of such hard spots. In fact, quite apart from steel mixtures, I have long held the opinion that the vigorous stirring of molten iron in the ladle would go a long way towards reducing the waster bill. In the iron foundry it is the exception rather than the rule to see the ladles of metal well stirred.

With regard to cupola-melted mixtures containing steel borings, I consider I have never had bad results directly attributable to the form of the scrap. I have been a fairly consistent user of steel scrap in cupola-melted mixtures for a number of years, and, whilst I strongly deprecate the title "Semi-Steel" and have no sympathy for extravagant claims for this material, I recommend the use of steel scrap at the present time as a delightfully cheap and easy way of producing a low silicon, low-phosphorus iron—"a good iron."—I am,

Yours, etc.,
J. E. HURST.

3, Sandilands, Troon, July 11.

CLAYTON & SHUTTLEWORTH, LIMITED, Lincoln, are supplying the L. & N.W. Railway with five large-sized "Clayton" patent water-tube boilers of curbed tube drum type, complete with superheaters, economisers, mechanical stokers and chimneys. The five boilers, which are similar to those being supplied by the firm to the London County Council for the Greenwich Power Station, are required by the L. & N.W. Railway for the Formby (Lancashire) Power Station, where developments are being undertaken in connection with the extension of electric railways.

American *versus* British Grey Cast-Iron.*

By F. J. Cook.

Rightly or wrongly, the average British engineer and foundryman considers that American grey irons of their respective class are inferior in physical properties to those of Great Britain. He bases this opinion, first of all, upon the undoubtedly poor wearing qualities of the cast iron which some years ago formed the material of the large quantities of machine tools sent to England. It was commonly said that the cast iron was so soft as to be easily cut with a pocket knife, a statement often enough literally correct.

Some Poor American Irons.

Recently, some improvement has been noticed, attributed partly to wider bearing surfaces and the application of chills on wearing parts, combined with the use of semi-steel. Nevertheless experiences are still related, in connection with the war, showing that American material frequently left a good deal to be desired. The author was familiar with an American machine supplied by a well-known maker which was commandeered by the Government for a special operation in connection with parts for large guns.

Owing to the poor quality of the cast iron the machine was constantly breaking down. No fault could be found with the design, which was excellent for its specific requirement; yet owing to the long periods when it was out of commission through breakdowns the output was less than that obtained from an improvised old machine. It was necessary to replace the broken parts with castings produced from local irons utilising the broken portions for patterns. These substituted parts proved quite satisfactory, and there was some foundation for the statement, although not strictly and literally true, that the only part remaining of the original cast iron in the machine at the end of the war was the name plate on the bed.

American Failures.

Writers of scientific papers in America frequently refer to the failure under superheated steam of cast-iron parts. This is a state of affairs unusual in England, grey iron castings being made without difficulty sufficiently strong to withstand working temperatures and pressures quite equal to those under which American castings have broken down—the composition of this more durable material being not widely different from the American irons which have proved unsuitable.

Some years ago an American technical journal with which the author was familiar regularly gave reports of burst flywheels, until at last it became quite natural to look for them with much the same amused interest as the readers of *Punch* anticipated the historical cartoon. English engineers regularly engaged in designing cast-iron flywheels up to a weight of 25 tons, having periphery speeds of not less than 100 feet per second, sometimes wondered as to the character of the remarkable material of which the American wheels were made.

Travel naturally widens one's views and extends one's knowledge, and conversely, there is a tendency on the part of the stay-at-home to become parochial and narrow. One of the results of the war has been a more frequent interchange of visits, and we on this side from a period shortly before the end of the war consider ourselves specially favoured in the visits we have received from many leading American foundrymen, whose eminence consists not only in foundry knowledge but in general accomplishments.

We hope they will pardon the amusement we have derived from the very candid opinions they have expressed in regard to us and our institution in the old days before, like the Queen of Sheba, they came to see for themselves. One American, for example, expressing the belief that British foundries were generally so badly lighted that an electic torch was necessary to find one's way about in them, and the moulding shops were so low that one had to be careful not to knock his head against the roof girders, was candid enough to say that the first British moulding shop he entered fairly took away his breath. After spending the whole afternoon in it, he regretted his inability to stay longer and see more. He discovered that he had only seen a small part of the whole, and was a little surprised at the offer of his guide that "any time he had a week to spare they would be pleased to show him the remainder." As a matter of fact, he was in the largest foundry in the world, and had no idea that so fine a concern could be found on the European side of the Atlantic.

The author has to admit that up to the present he has been among the stay-at-homes, and is quite prepared to find that his references to American practice will furnish foundrymen on the other side of the Atlantic with at least as much amusement as Britishers have derived from Americans and their opinions of Great Britain. The great purpose of the paper, however, is to furnish a basis for a good discussion, and it may be hoped that this object will be realised.

As the subject of grey cast-iron obviously is too wide to be dealt with in a single paper, it is proposed to limit its scope to the consideration of grey cast-iron made from commercial pig-irons, and cast-iron scrap melted in a cupola by means of coke, and without the addition of steel or any ferrous or non-ferrous materials introduced either into the cupola or the ladle of molten metal.

Conditions of Test Vary.

When one comes to deal specifically with mechanical tests the fact has to be faced that the conditions relating to mechanical tests for cast iron vary considerably in the two countries. Little importance appears to be attached in America to tensile testing, while the size of the transverse bars tested, differs widely from British practice. The ruling tests for cast iron may be said to comprise in Great Britain: For pipes, constructional and general engineering work for more or less rough and large character, transverse bars, 2 inches deep 1 inch thick and tested deep part down on centres 3 feet apart; for engine details other than cylinders, transverse bars 1 inch square tested on centres 12 inches apart. It is also becoming more general in the finer classes of engine work to cast the transverse bars $1\frac{1}{4}$ inches square, machining down to 1 inch square to insure accuracy. For cylinders of all descriptions, tensile bars exactly of the same material as the castings they are to represent are demanded. Practically every tensile bar has to be tested in the presence of an inspector, and the casting of the bars on the job therefore generally gives more satisfaction and prevents the suspicion which might possibly arise if the bar was separately cast without the presence of the inspector. There is a great deal also to be said in favour of the tensile test for cylinders, since the castings themselves are necessarily subjected to tension. Moreover, a tensile test gives a better indication of the wearing properties of this class of iron than any other test known to the author.

It may possibly be that the apathy with which the tensile test in America is regarded may to some extent be due to certain conditions named by Dr. Moldenke, though of that, of course, the author is not in a position to judge. Dr. Moldenke says†:

"In this country (America) you will find about 99 out of 100 testing machines that are not in proper condition for the tensile test. On the other side they calibrate the machines often, and they have their Governments to test them."

There can be no gainsaying his further statement on the same page that "for scientific investigation the tensile bar is preferable."

The reading of American scientific papers and of the technical Press conveys the impression that a tensile test going a little beyond 14.0 tons is considered worthy of special notice; certainly in Great Britain anything like this would be considered

* The Institution of British Foundrymen's Exchange Paper read at the Rochester Conference of the American Foundrymen's Association.

† American Foundrymen's Association, "Proceedings," vol. 22, p. 368.

quite mediocre. Mr. Ernest Wheeler,* representing Messrs. Crossley Brothers, Limited, Manchester, states that he has found it " quite possible, without the aid of steel to prepare and obtain mixtures of cast iron having a tensile strength of over 18 tons per square inch," and this is confirmed by other workers in the same field. The same gentleman has prepared for the author a bar cast in accordance with the specification for the " Arbitration bar," which has given a result of 17.5 tons.

Tensile Tests.

A short time ago the author tabulated his average tensile test results over a working period of 500 consecutive days. The average figure was just over 16 tons per sq. in.; no test was as low as 13.5 tons, while the highest figure reached was 19.2 tons. All the bars were 1¼ inches diameter and were cast on the castings they were to represent—not separate—and were turned down in the middle to ½-square inch area before testing. A typical range of tensile test results with this class of iron with the accompanying analysis is given in Table 1.

Table I.—*Results of Tensile Tests.*

Analysis.						Tensile test result, tons per sq. in.	Transverse test equivalent lbs. per sq. inch on Arbitration Bar.
C. C.	G. C.	P.	Si.	S.	Mn.		
0 98	2.074	0.974	1.213	0.146	0.324	14.6	5146
0·84	2.214	1.046	1.166	0.136	0.432	14.6	5146
0..89	2.410	1.140	1.40	0.134	0.453	16.1	5146
0.66	2.498	1.186	1.40	0.136	0.465	17.5	5373
0.84	2.432	0.981	1.143	0.137	0.288	18.4	5562
0.72	2.49	1.2	1.49	0.126	0.420	19.9	5600

For mechanical tests to be strictly comparable it is essential that the bars should be of the same dimensions and similarly moulded, gated, cast and tested. It may be argued, therefore, that the tensile test results given in Table I. are not comparable to those obtained by the American arbitration bar. But the author suggests that in this respect the advantage has not been with those cited. The bars were of the same dimensions as the arbitration bar, and they certainly had the advantage of static pressure due to casting head, as they were placed on the middle joint of short-stroke cylinders. They have one disadvantage, however, in that they were cast with cooler metal than if they had been cast from a small ladle direct from a cupola, while the rate of cooling is slower, owing to their having been cooled down in close proximity to a larger body of metal. The disadvantages of all these conditions were well set out in the admirable exchange paper presented by George K. Elliott to the Institution of British Foundrymen last September.

Comparisons between the transverse tests made in the two countries are necessarily hampered by serious difficulties, chiefly on account of the difference in shape and dimensions of the bars used. The arbitration bar has a diameter of 1¼ inches and is tested as cast, on centres 12 inches apart. The bars with which the author is familiar and of which particulars are given later are cast 1¼ inch square, machined down to 1-inch square, tested on 12-inch centres, and cast on to castings as previously defined in connection with the tensile test.

Constant Necessary.

In the absence of an available machine suitable for taking a bar of 1¼ inches, it has been necessary to evolve a constant which will reconcile the differences of dimensions in the two bars.

The results of the arbitration bar can be converted into those comparable for a 1-inch square bar tested on the same centre by multiplying the breaking load obtained by 0.74; conversely the result obtained on the 1-inch square bar divided by 0.74 will give the equivalent load in the arbitration bar. The formula used for obtaining this factor is given in the appendix to the paper.

In the discussion on Elliott's paper already referred to, the author gave some details of 25 transverse tests of bars giving an equivalent average breaking load on an arbitration bar of 5,300 pounds; the lowest bar gave an equivalent load of 5,146 pounds, and the highest 5,600. The minimum load is a higher figure than that obtained by Mr. Elliott with American metal having a similar silicon content, but with lower phosphorus and sulphur after undergoing the refining action of an electric furnace.

Table I. gives particulars of the transverse results brought up to an equivalent on the arbitration bar relative to bars cast on the same cylinders as those selected for the tensile example.

Keep's Tests Compared.

Although the two previous tests are not in the strictest sense comparable, there is a mechanical test common to both countries, namely, Keep's shrinkage and transverse test. The author was probably the first in Great Britain to have at his disposal a complete set of Keep's machines, and the present opportunity is gladly taken to acknowledge the great value of the shrinkage and transverse test in connection with this class of cast iron.

A rather lengthy correspondence took place with Mr. Keep relative to the working of the transverse machine with the ½-inch shrinkage bars. Mr. Keep expressed the opinion that the alignment of the machine had become affected during its transit. He arrived at his conclusion from the high results shown in the diagrams forwarded to him. In regard to these he said: " Probably we should not have a ½-inch square bar to break at over 425 pounds." Nothing could be found wrong with the machine, and as the result appeared to be borne out by other mechanical tests taken on bars of varying sizes from the same metal a few ½-inch bars were sent to Mr. Keep with a diagram of the corresponding bar in each set. The breaking loads varied from 590 to over 700 pounds. Mr. Keep replied as follows: " I did consider the high results obtained as due to your machine being out of order, but I was mistaken, as my machine gives the same results. The iron is remarkably strong: I don't know of anything as good."

In Great Britain we consider Mr. Keep knew all about the mechanical tests that American irons will stand. The results shown in Table II. of tests made with the same class of iron as those dealt with in Table I. are not only typical of results obtained by the author but of those secured by other workers.

Table II.—*Keep's Tests on Cast Iron.*

Shrinkage inches.	Transverse Breaking Load in pounds.	Deflection inches.
0.146	550	0.14
0.161	600	0.15
0.157	650	0.18
0.158	675	0.19
0.159	700	0.21
0.161	800	0.23

Thirty tests on this same size bar gave an average breaking load of 622 pounds.

The general practice differs somewhat between the two countries in regard to the allowable percentage of the chemical elements in different classes of grey cast-iron. This is undoubtedly due to prevailing differences in the irons, and not to a lack of metallurgical knowledge.

Briefly stated, some of the principal differences are as follows:

With one or two notable exceptions, practical foundrymen in America appear to pay little attention to total carbon. While carbon receives special attention and is frequently mentioned, it is only lately that total carbon has had due consideration. The quantity of combined carbon is important, but it is obvious that with varying amounts of total carbon the same percentage of combined carbon will have a different effect. Dr. Stead† has shown examples in which increases of 0.1 per cent. of graphite have reduced transverse strength by 224 pounds and tensile strength by 8 tons per square inch.

Silicon receives a great amount of attention in American foundry practice, and in conjunction with sulphur appears to be regarded as the Alpha and Omega by the purchasers of pig irons. One hears a great deal of " silicon control." In Great Britain silicon is merely considered with all the other elements entering into a commercial analysis. It must not be supposed that there is any lack of appreciation of the value of silicon, since in Birmingham—the home of Professor Turner—it is probable that more research work has been done with regard to the influence of silicon than in any other centre. A formula which

* Manchester Association of Engineers, " Proceedings," 1921.

† British Foundrymen's Association, " Proceedings," 1915.

the author has used for many years with marked success in connection with the ratio of silicon to carbon in grey cast-iron mixtures is as follows:

$$X = \frac{C}{4.26 - \frac{Si}{3.6}}$$

where X = the ratio of silicon to total carbon
C = total carbon present.
Si = Silicon present.

$X = 0.9$ to 1 for such work as pipes, grates, easily machined castings and general work.

$X = 0.83$ for locomotive cylinders and castings requiring *maximum transverse strength*.

$X = 0.76$ to 0.82 for steam, gas, oil and diesel-engine cylinders, and castings requiring *maximum tensile strength*.

$X = 0.75$ to 0.8 for chilled castings.

$X = 0.85$ for acid-resisting castings.

Effect of Sulphur and Phosphorus.

At one time in this country sulphur was considered the arch enemy of the ironfounder, although probably it is not taken quite so seriously as it is in America. In his exchange paper George K. Elliott considers that sulphur above 0.07 per cent. is dangerous. This does not agree with the results of Coe's* research on British irons. Coe found that sulphur within the limits of his work did not increase the brittleness of cast iron but appears to increase resistance to fracture.

In Table I. the sulphur appears in a proportion twice the amount which Mr. Elliott considered dangerous, yet it does not appear to have prevented a high degree of strength being obtained. A liberal proportion, up to 0.12 per cent., has, in the author's experience, been found to have a beneficial effect upon the wearing properties of cylinders and liners subjected to heat conditions, while no difficulty has been met with in the way of blow holes provided the metal has been melted and cast hot.

To an appreciable extent phosphorus is considered in America to be detrimental to the strength of grey cast-iron. George K. Elliott, in his paper, states "Irons of greatest strength contain only a small amount of phosphorus." Dr. Moldenke, in "Principles of Iron Founding," appears to put the limit for strong castings free from strains at 0.4 per cent. The author's experience points to the conclusion that with the strongest British iron the *distribution* of the phosphorus, provided the amount does not exceed 1 per cent. is more important than the actual quantity present. Phosphorus in a segregated form, the usual form in all weak irons, is dangerous where strengths are required, but provided it appears in the network or cellular form no detriment to strength is experienced with phosphorus up to 1 per cent. This form is assisted so long as the silicon and total carbon are restricted in the ratio appearing in the formulæ for strong irons.

Manganese Held to be Detrimental.

Agreement appears to be more general in regard to the benefit to be derived from the poling action of manganese, but the author believes that manganese to the extent of 1 per cent. or over is detrimental to good wearing properties under heat conditions. This element has a way of developing spikey crystals which break off under rubbing and prevent the formation of that highly polished surface generally regarded as the distinguishing characteristic of all good-wearing cast iron. Apparently there is much to be gained by keeping this element restricted to the proper proportion called for by the amount of sulphur present, and for this purpose manganese should not exceed five times the amount of sulphur; beyond this proportion there is a danger of the formation of manganese carbide.

Although chemical analysis necessarily forms the basis of all scientific work in regard to cast iron, it does not follow that similar analyses necessarily involve similar physical properties. It is also admitted that strong grey irons are associated with the matrix consisting of fairly large areas of well-defined laminated pearlite, relatively stiff portions of cementite and small graphite, and these formations are illustrated by typical examples in Figs. 1 and 2.

* British Foundrymen's Association "Proceedings," 1911-12.

While the microscope is a useful adjunct to chemical analysis, the utility of the micrograph is limited; it being impossible to determine therefrom relative physical properties of specimens with mathematical precision, or to ascertain within narrow limits the relative variations. In all probability this is due to our imperfect knowledge of both subjects, and it may be hoped that further research will clear up some of these matters.

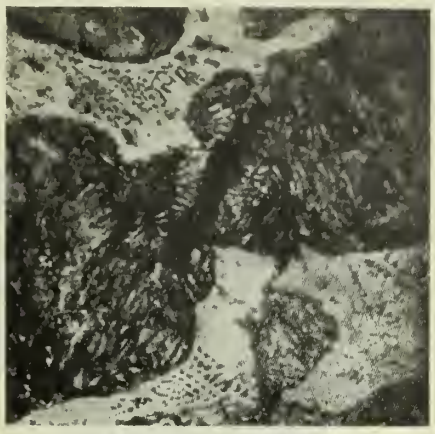


Fig. 1.—Matrice Consisting of Well-defined Luminated Pearlite.

Occasionally it is quite impossible, in dealing with this class of iron, to discover either by chemical analysis or the usual methods of microscopic examination great differences in physical properties. An interesting example of this took place some time ago. It was found that the highest tensile test obtained in sixty consecutive days' workings was lower than the lowest tensile test during the next sixty days. The metal was of similar chemical analysis, but the mixture had been varied by introducing a different pig-iron brand as one of the three constituting the charge.

A research was carried on by the late George Hailstone and the author† in connection with this class of investigation. All the methods usually employed for detecting the cause of difference in physical properties, such as chemical analysis, high and low power microscopic analysis, and the employment of various etching agents, failed to show any reasonable cause for the great difference which existed.

As a further test, specimens were deeply etched with 20 per cent. nitric acid in water as suggested by Stead, and afterwards re-examined under low

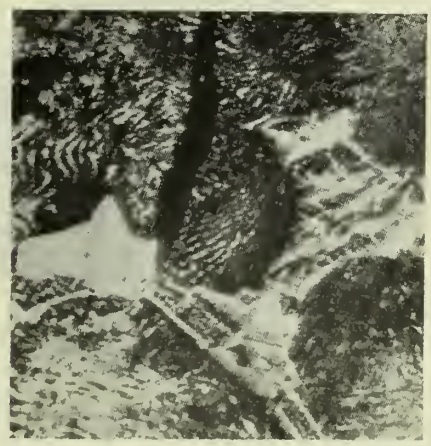


Fig. 2. Note Cementite and Small Flakes of Graphite.

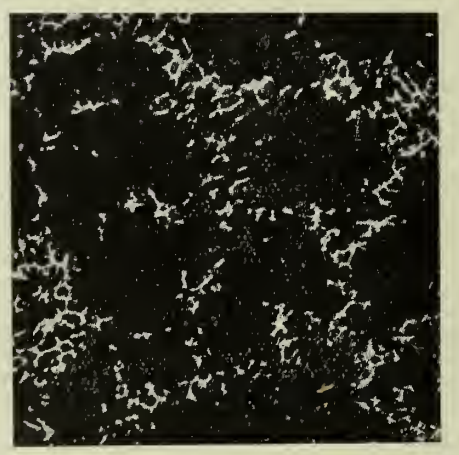
magnification. It was then found that the strength of the material was directly related to the particular formation of the cementite and phosphide eutectic. The stronger the iron, the clearer were these two microscopic elements in the network formation, as will be seen from Figs. 3, 4, and 5.

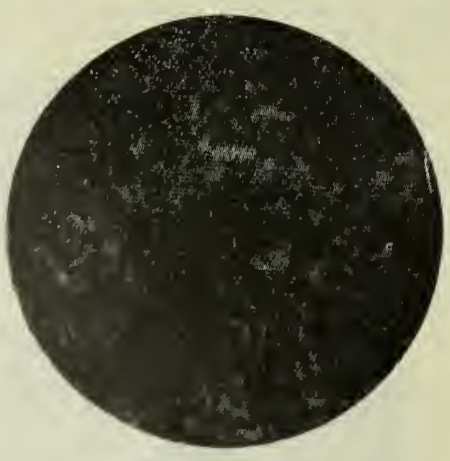
The author has made many hundreds of examinations in order to test this, and has never found a single example to the contrary. The network formation is apparent at about 12 tons tensile strength, and becomes more pronounced as the

† British Foundrymen's Association, "Proceedings," 1908-09.

strength increases. In the author's view, this method gives a surer approximation of the physical properties of the metal than any other form of metallography, and is often superior to chemical analysis. It must be remembered, however, that the field under observation must be typical of the whole. The accompanying illustrations are from micrographs taken from the centre of the bar.

In connection with the research already referred to, the authors, as one of their conclusions, decided that the temperature at which the pig iron is made in the blast furnace has a direct





Figs. 3, 4 and 5. Micrographs Showing Network of Cementite and Phosphide Eutectics—Deeply Etched with 20 Per Cent. Nitric Acid Solution.

effect upon the formation of this network structure. At the time this statement aroused a great amount of criticism, one professor stating that, after remelting, the iron had forgotten all about the hole from which it had been dug. Time has since proved the inaccuracy of this view, and it is now clear that the temperature of the blast furnace has a marked effect upon the physical properties of the metal, and that these are maintained after remelting.

One progressive blast-furnace manager has found that pig-iron having this network structure, after going through the puddling furnace, yields wrought iron with higher physical properties than is to be obtained from a pig-iron of similar analysis without this structure. He discovered further that with similar working and furnace burden the network structure was controlled by the blast temperature. When using a blast temperature of 900 degrees Fah., he is always able to get the network structure; whereas, if the temperature is increased, the network diminishes until at 1,100 degrees it disappears entirely, with a corresponding lowering of physical properties of the wrought iron, the general chemical composition of the metal being the same. As the result of these discoveries, the blast-furnace manager has now fitted his furnace with pyrometers for recording the temperature of the blast, and is able thereby to obtain more regularly consistent results.

Network Structure Increases Strength.

Another criticism by a well-known metallurgist was that, although greater tensile strengths were associated with a network formation of the cementite and phosphide eutectic, he thought the metal would give less resistance to shock or fatigue.

Rotary fatigue tests were taken by the Wheeler method by the Sheffield testing works on the bars whose structure is shown in figs. 3 and 4, and these are given in Table III. Fig 6 gives details of the method of applying the test and the dimensions of the test bar. The comparative results are even wider apart than appears from the tensile results.

Table III.—*Results of Chemical and Physical Tests.*

Chemical analysis	Tensile strength, tons per sq. in	Rotary fatigue test results. Revolutions per minute	Fibre stress tons per sq. in.	Total number revolutions to produce fracture.	Appearance of fracture
	9.1	980	11	100,800	Fracture sound
T.C. 3.25%					
G.C. 2.397					
C.C. 0.853		980	5	10,000	Fracture sound
Si. 1.328	9.1	980	6	9,200	Slightly open.
S. 0.95					
P. 0.923				19,200	Grained
Mn. 0.290					
T.C. 3.192					
		980	5	10,000	Major Portion Fine Grain but trace unsound near periphery
G.C. 2.289		980	6	10,000	
		980	7	10,000	
C.C. 0.903		980	8	10,000	
		980	9	10,000	
Si. 1.314	18.3	980	10	10,000	
		980	11	10,000	
S. 0.101		980	12	10,000	
		980	13	10,000	
P. 0.909		980	14	10,000	
		980	15	800	
Mn. 0.335				100,800	

The fundamental law governing the phenomena of the formation of the network structure has not so far been definitely and satisfactorily proved. J. E. Fletcher, however, has furnished an explanation which has the greatest degree of probability. Mr. Fletcher is advising director to the British Cast Iron and Wrought Iron associations and has devoted much thought and research to the elucidation of this problem in connection both with the blast furnace and the cupola. His explanation is as follows:

He believes that this structure follows the original boundaries between the crystals of the metal which is first fused during the descent of the iron to the fusion zone in the blast furnace. The carbonisation of the crystals follows their boundaries as decarbonisation follows them in the mechanism of the malleablising process.

If the blast penetration effect while passing the tuyere zones is drastically oxidising, following rapid carbonisation in hot-blast furnaces, then the strong boundary intercohesion is more or less destroyed, with possible gas and oxide inclusions along the boundary films.

With the soft blast of cool or cold-blast furnaces this action is absent, and the intercohesional strength of the crystalline structure, due to the presence of combined carbon and air—unimpaired by gaseous and iron oxides and minute slag inclusions—is maintained.

Shock Test Advocated.

Points which the author has found helpful in producing regular results with this class of iron have been close attention to chemical analysis and

regular testing for general hardness by the drill method. But it should be remembered that with these strong irons a much stiffer machine is required than that known as the Keep's machine. Owing to its lack of rigidity the author's experience with this machine has been disappointing.

Regularity of hardness, which is a governing factor of high physical properties, is only attainable by strict attention to blast pressure, and in this connection a recording blast pressure gauge attached to the cupola is most desirable.

A test becoming general in Europe for cast irons of the highest physical properties, more particularly in connection with casting for Diesel and large gas engine piston and cylinder liners, is the shock test. This is carried out by testing a bar cast 40 millimetres square supported on knife edges 160 millimetres apart by dropping on to it a weight of 12 kilograms from varying heights. Attached to the weight in such a way as to strike the bar in the centre parallel to the supporting knife edges is fixed another knife edge. The face of all the knife edges are rounded to a 1/16-inch radius. So far as the author is aware this test is not in use in America. A general arrangement of such a machine is shown in Fig. 7.

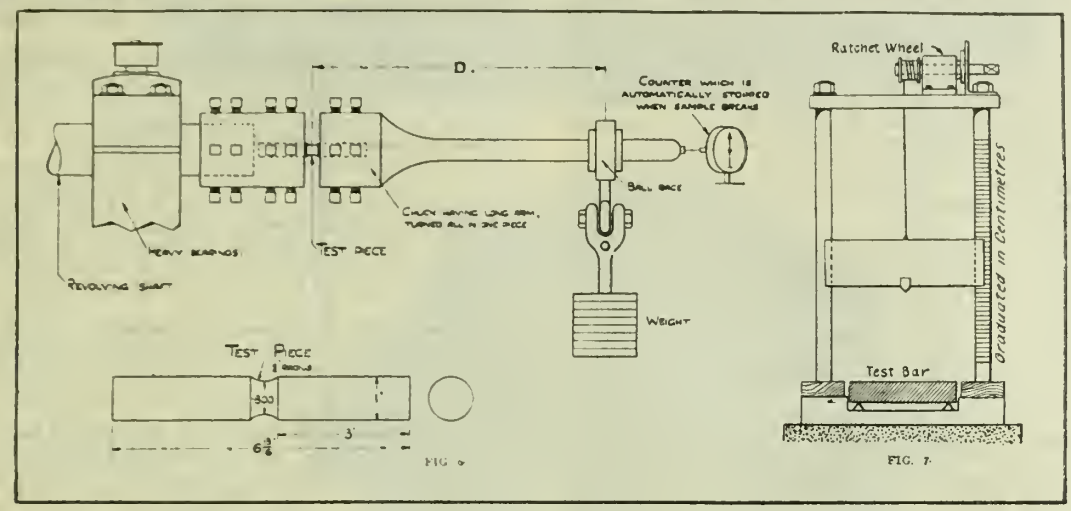


FIG. 6. FIG. 7.

In carrying out a shock test we commence with a drop of the weight from a height of 30 centimetres, increasing the height of the drop by increments of 5 centimetres until the sample breaks, the height at which the bar eventually breaks being taken as the test figure. A result of 55 centimetres is considered none too high for the class of work named, although it is quite a severe test. The maximum attained by the author has been 88 centimetres.

Mr. Wheeler uses the same sized bar and machine as a fatigue test, but for this commences with a drop of 28 centimetres and increases by heights of 1 centimetre. The number of blows required to fracture the sample should be taken as the fatigue-test numeral.

A bar from the same metal as the tensile bar of Mr. Wheeler's referred to in the early part of the paper withstood 30 blows, having a range from 28 to 57 centimetres.

In conclusion, as has been suggested in the first part of this paper, there is a wide difference in the strength of the respective grey cast-irons, of which some particulars in regard to the British have been given, the author would suggest the query whether this may not be due to the slow running furnaces in Great Britain producing metal having better properties than that made by the large fast running furnaces which appear to be general in America. Unfortunately, even in Great Britain the slow running furnaces are diminishing in number.

The author's best thanks are due to Professor Turner for help with some of the micrographs, and to Messrs. Bellis and Morcom for their permission to publish some of the results.

Mr. Charles Southeran, one of the head officials of Dorman, Long & Company, Limited, Zetland Road, Middlesbrough, has been the recipient of a presentation on the occasion of his retirement after forty-two years' service

Display Facilities for British Travellers in New York.

His Majesty's Consul-General at New York (Mr. H. Gloster Armstrong) calls attention to the facilities which are now available to the representatives of United Kingdom firms visiting New York, at the offices of the British Empire Chamber of Commerce in that city. The Chamber, which has recently taken new premises in the Cunard Building, 25, Broadway—one of the largest and most modern structures in the city—has arranged for the formation of a sample room where British commercial travellers can, for a moderate charge, exhibit their goods, take orders, obtain office facilities and clerical assitance, and generally make it their headquarters during their stay in New York.

The Consul-General feels that this arrangement should prove extremely useful to the representatives of British firms, enabling them to display small samples in economical and advantageous circumstances. British travellers visiting the United States with samples have in the past been greatly hampered and delayed by the necessity of negotiating for a suitable room before circularising their customers.

It is suggested that firms requiring the use of the sample room for their representative should communicate with the Chamber well in advance, at the same time furnishing a list of their American customers, to whom the Chamber would then issue official invitations to meet the representative at a fixed date. Local firms known to the Chamber as interested in the trade concerned, though not listed as customers of the firm, would also be communicated with in the hope of securing their custom. It is understood that the Chamber would also render assistance, if desired, in the issuing of circulars or in the distribution of catalogues or literature, on basis of cost. The charge for rent will be $10 per day per room, inclusive of light and heat.

Contracts Open.

Exmouth, July 24.—Supply of about 45 tons of 6-in. cast-iron pipes and specials, for the Exmouth Urban District Council. Mr. S. Hutton, engineer and surveyor, Council Offices, Exmouth.

Maldon, Essex, July 25.—Supply of about 2,120 yards 4-in. cast-iron pipes, for the Maldon Rural District Council. Mr. W. Almond, engineer, 6, Market Hill, Maldon, Essex.

Warrington, July 24.—Supply of cast-iron circulating pipes, steam pipes, feed tank, etc., for the Electricity and Tramways Committee. Mr. F. V. L. Mathias, borough electrical and tramways engineer, Howley, Warrington. (Fee £1 1s., returnable.)

Mr. N. Kilvert, J.P., chairman of Browett, Lindley & Company, Limited, of the Lancashire Dynamo and Motor Company, Limited, and of the Lancashire Ordnance Accessories Company, Limited, who died on March 24 last, aged sixty-three years, left estate of the gross value of £176,863, with net personalty £128,501.

Trade Talk.

Mr. Charles Erith, trading as Charles Erith and Company, has removed to Palace Chambers, Bridge Street, London, S.W.1.

Mr. J. Dentith, iron and steel merchant, has removed from 6, Stephenson Place, to Furness Chambers, Stephenson Place, Chesterfield.

Truslove & Company, Colchester, have appointed Mr. J. Sambidge as their London manager at 17, Victoria Street, Westminster, S.W.1.

The Stamping & Press Tool Company, Limited, have removed from Oaklands Road, Cricklewood, to Station Works, Richmond, Surrey.

The British Thomson-Houston Company, Limited, are supplying the Aylesbury Town Council with a turbo-alternator at a cost of £10,302.

The Midland Machinery Company, Limited, have removed from 108, Dale End, to the Chamber of Commerce building, New Street, Birmingham.

The North Birmingham Iron & Steel Company have removed from 28, Selborne Road, Handsworth Wood, Birmingham, to George Road, Solihull.

It is reported that the furnace at Cleator Moor, belonging to the Whitehaven Hematite Iron & Steel Company, Limited. will be put out of operation immediately.

After a stoppage extending over sixteen months, the furnaces of the United Steel Companies (formerly Messrs. Butlin's), Wellingborough, have now been lighted again.

George F. West & Company, Iddesleigh House. Westminster, S.W.1, have terminated their sales agency arrangements with the Widnes Foundry Company, Limited, Widnes.

The tender of the Metropolitan-Vickers Electrical Company, Limited, submitted to the Wellington City Council, for the supply of electrical material at their new power house, has been accepted.

Alfred Herbert, Limited, Coventry, have been appointed sole selling agents in Canada for the mining machinery, air compressors, rock drills and pneumatic tools made by Holman Bros., of Camborne, Cornwall.

The imports of foreign iron ore at the Senhouse Dock at Maryport for the half year ending June 30 were 43,800 tons, compared with 8,200 tons for the previous six months, and 25,000 tons at the corresponding period of last year.

Dorman & Smith, Limited, have appointed Mr. H. J. D. Thompson to represent them on the N.E. Coast, and Mr. Thompson has opened an office at 28, Grainger Street, Newcastle-on-Tyne, where he will deal with inquiries for switchgear, fittings, etc.

A trust deed dated June 14, 1922, to secure £1,500,000 first debenture stock, has been registered by the Consett Iron Company, Limited, in connection with the recent public issue of debentures. This constitutes the first entry on the company's "register of mortgages and charges" since its incorporation in 1864.

Some recent foreign orders secured by Automatic & Electric Furnaces, Limited, include three from India, six from Norway, one from Australia, two from France, one from Spain, three from Holland, one each from Japan, Denmark and Buenos Aires, and two from Germany.

The Underfeed Stoker Company, Limited, have lately taken orders for travelling grates and ash conveyors from the St. Helens, Amsterdam, Dover, Penarth, Belfast, Sydney (N.S.W.), and Osaka Electric Light and Power Stations, and the Lewis Merthyr Collieries, Great Mountain Collieries, Coppee Company, Pentremawr Collieries, and James Nimmo & Company.

The Spearing Boiler Company, Limited, have been successful in securing the contract for a complete boiler house equipment, consisting of three boilers, each of a normal evaporation of 50,000 lbs., together with Ferguson superheaters, economisers, mechanical stokers, induced draught plant, chimneys, steam, feed and other pipework, and ash handling plant, for the Stepney Borough Electricity Department.

Mr. J. J. Burton, of Middlesbrough, intimates that he has resigned his position as managing director of the Tees Furnace Company, Limited. Arrangements have been made by which the Roseberry and Ayton Banks Ironstone Mines, hitherto carried on by the Tees Furnace Company, Limited, will in future be carried on by Mr. Burton and his son, Mr. George A. Burton, under the name of Burton and Son.

Out of a deficit of £1,040,173 in the accounts of the Ordnance Factories for the year ended March 31, 1921, £582,763 is for work done in the manufacture at Woolwich of 100 locomotives for which no definite purchasers had been obtained. The Controller says that further expenditure has been incurred since, and the locomotives have been reported to the Disposal and Liquidation Commission for sale, but he is not aware that any have yet been sold.

Company News.

Greenwood & Batley, Limited.—Final dividend, 3½ per cent., making 6 per cent.

B. H. Hirst, Limited.—Capital £400. General engineers, etc. Directors: B. H. Hirst and H. E. Frith.

Falkland Engineering Company, Limited, 140, Falkland Road, Harringay, N.—Capital, £2,000 in £1 shares. Directors: A. E. Hemingway and J. A. Brough.

Gloucester Railway Carriage & Wagon Company, Limited.—Dividend for half-year to May 31, 10 per cent. per annum, making 10 per cent. for year, less tax.

Rother Iron Works, Limited, the Fishmarket, Rye, Sussex.—Capital £10,000. Permanent directors: L. G. Walters, G. T. Jennings, G. Lomer, and E. H. Prior.

Vickers, Limited.—Profit, £708,103; brought forward, £991,639; preference dividend, £395,707; ordinary dividend, 5 per cent. per annum, less tax; carried forward, £872,993.

Albro Fillers & Engineering Company, Limited, 34, Holloway Road, N.—Capital £1,100 in 2,000 ordinary shares of 1s. each and 1,000 5 per cent. preference shares of £1. Secretary: M. O. Sheppard.

Binns & Mander, Limited, 179, Thornton Road, Bradford.—Capital £20,000. Engineers, founders, manufacturers of engines and machinery of all kinds, etc. Directors: D. H. Binns, W. Binns, and J. D. Mander.

Scammell Lorries, Limited, Fashion Street, Spitalfields, E.—Capital £250,000. Directors: J. Allan (chairman), Lt.-Col. A. G. Scammell, P. G. Hugh (technical director), A. I. Bellisha, H. L. Mond, and E. W. Rudd.

Horseley Bridge & Engineering Company, Limited.—Profits, £19,190; brought forward, £12,384; available, £31,574; dividend for year, 5 per cent., free of tax; reserve fund (increasing this account to £90,000), £10,000; carried forward, £9,074.

Essex Engineering & Machinery Company, Limited, 11, Tavistock Square, W.C.1.—Capital £3,000 in 120 preference shares of 1s. and 2,994 ordinary shares of £1. Directors: C. H. J. Gooch, Mrs. M. A. White, J. R. S. Hawker (secretary), and T. J. White.

Falkirk Iron Company, Limited.—Further dividend, 5 per cent. actual, less tax, making 10 per cent.; depreciation, £5,877; debenture trust reserve, £4,500; formation of company and debenture issue, £8,554; reserve for depreciation of investments, £5,560; carried forward, £40,678.

General Electric Company, Limited. — Net profit, £566,581; brought forward, £348,093; total, £914,675; debenture stock interest, £182,431; depreciation, £161,744; contribution to pension fund, £15,282; dividend on A preference, 6½ per cent. per annum, £110,876; dividend on B preference, 7½ per cent. per annum, 121,717; available balance, £322,622; ordinary dividend, 5 per cent. per annum, £105,598; carried forward, £217,024.

Gazette.

Messrs. J. H. Collie and F. B. Cox, consulting engineers and agents, 65, Fleet Street, Liverpool, trading as Collie & Cox, have dissolved partnership.

The Melvin Engineering Company, Limited, is being wound up voluntarily, with Mr. H. F. Inkson, Guildhall Annexe, 23, King Street, London, E.C.2, as liquidator.

The partnership heretofore subsisting between Messrs. G. H. White, W. H. Brindley, and F. Osborne, engineers, Bailey Street, Sheffield, under the style of the St. Thomas General Engineers, has been dissolved.

Mr. F. Ridgway and Mr. T. Tynan, 21, Bowling Old Lane, Bradford, trading under the style of Ridgway & Tynan, electrical engineers, are paying first and final dividends of 4s. 7d. and 10d. in the £. respectively in their separate estates.

Receiving orders have been made in connection with the affairs of Mr. R. Springer, 253, Plymouth Grove, Manchester, electrical engineer and contractor, and Mr. E. G. Rowe, 119, Dunraven Street, Tonypandy, Glamorgan, who traded as Davies & Rowe, electrical engineers.

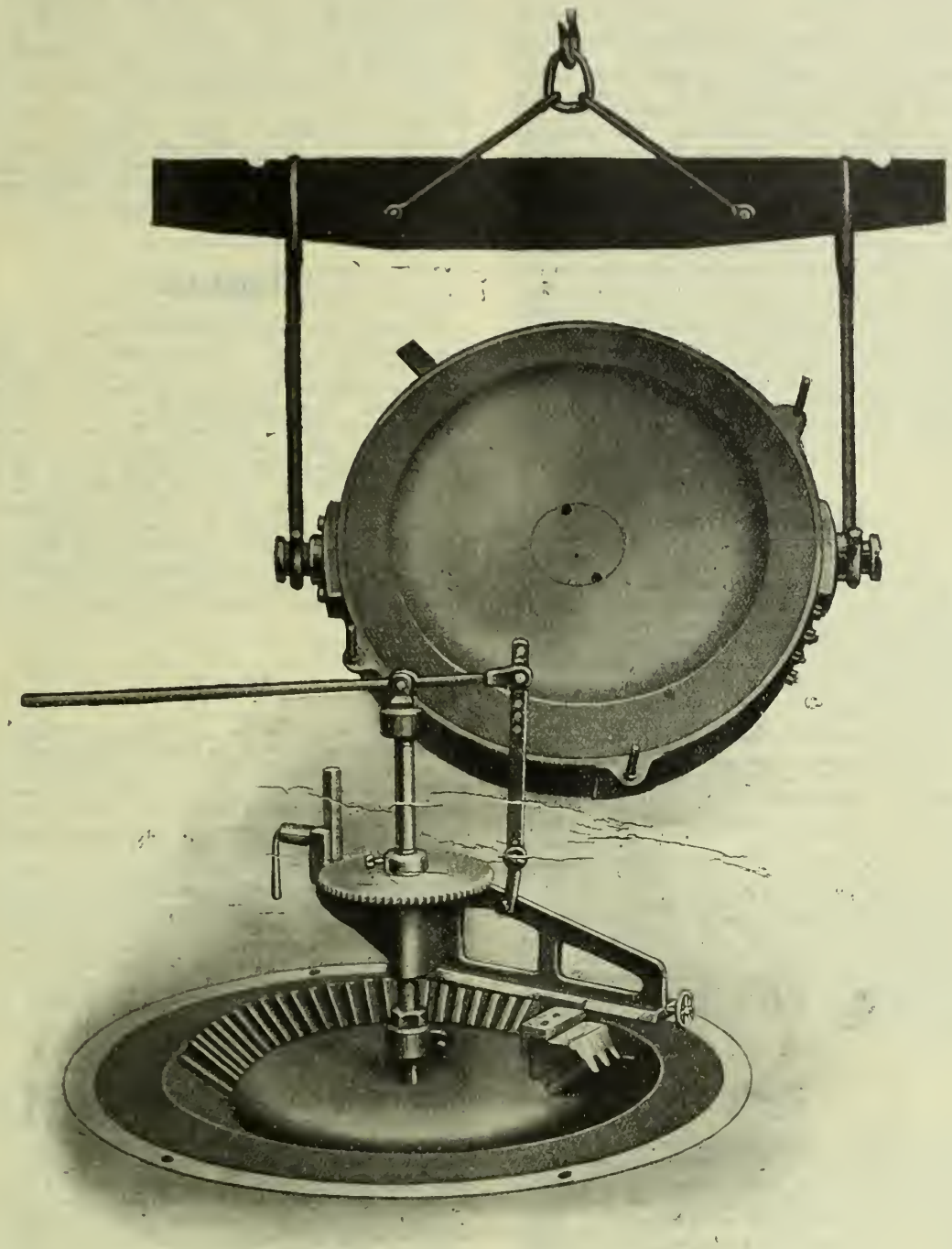
Messrs. A. G. Clowes and G. Anderson, iron and steel merchants, trading under the style of Clowes & Anderson, at Pheasant Grounds, Carbrook, Sheffield, have dissolved partnership. Mr. A. G. Clowes will continue the business under the style A. G. Clowes & Company.

The late Mr. George Hill, of Victoria Cottage, Station Road, Shotts, Lanark, and of the Calderhead Foundry, Shotts, left £11,887.

Since the first appeal was issued in May, 1920, a total of nearly £7,400 has been subscribed towards the War Memorial of the Imperial College of Science and Technology. A memorial tablet has been erected and unveiled in each of the three constituent colleges, and the remainder of the money has been used in part purchase of a sports field.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED,

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

The general position of the pig-iron trade during the past week, though practically unchanged in essentials, has certainly marked one outstanding development in the decision of the Cleveland ironmasters to restore the freedom of the markets as regards price adjustments, which, as in pre-war times, are in future to be left to the individual judgment of makers, and is a return to normal trading conditions. The announcement was received on 'Change with general satisfaction as betokening the final emancipation of the trade from the restrictions, both official and self-imposed by which the trade in pig-iron has so long been shackled. The termination of the Cleveland fixed price agreement has quickly followed the attempt of the Scottish makers to revive interest in warrant operations; so far, however, with little success, Iron Ring sellers' offers failing to stimulate business of a speculative order. Glasgow Fair holidays having commenced, business on Clydeside is practically suspended, but a hopeful view of the future is entertained in pig-iron circles, although as yet there have been few movements to justify general optimism in that direction. Offers of Continental pig are reported at favourable cut prices, but, so far, Scottish makers are holding for firm quotations.

Finished Iron.

The quarterly meeting at Birmingham last week, which was well attended by representatives from all parts of the country, disclosed a much more confident and hopeful tone than has been usual of late, based on an expansion of general demand and an encouraging volume of inquiry. Complaints are, however, expressed that the business offering at current prices affords but a bare margin of profit to manufacturers, some of whom are in consequence reluctant to restart operations. In one direction, at all events, some remedy for these conditions may be effected by the recent announcement of a further reduction in transport charges by the railway companies, which should, to a partial extent relieve the situation. A little more active demand is noted for the lower-grade bars, material for nuts, bolts, fencing, etc., finding a fairly steady market at about £10 to £10 10s. On the other hand, South Staffordshire crown iron is very irregular, some makers quoting the full rate, £11 15s., although a fair quality can be obtainable at £1 less. Makers of marked bars, S.S brands, are fairly well employed, and are also hopeful of benefiting from improved conditions of trade following the cessation of recent labour difficulties.

Steel.

Although only slow progress can be reported towards returning activity in the steel industry, signs of an early revival are by no means entirely absent, manufacturers deriving encouragement from the position in the States, any improvement in that market being accepted here as signalling a revival of the world's demand for material. That this assumption is justified is to a certain extent confirmed by a steady increase in orders and inquiries on American account, last month's shipments to Atlantic ports having been heavier than for the past twelve months. With regard to the armament departments, there is still some work on hand for both the United States and home Governments, while the recent decision to place contracts for two capital ships for the Navy in hand will go far to relieve unemployment in the heavy steel branches. Demand for steel for engineering and constructional purposes is slow in materialising, the branch most favoured so far having been the production of textile machinery, for which orders in hand include important contracts both on home and overseas account, though business is in many cases still retarded by buyers' anticipations of lower prices in the near future. Export trade in agricultural machinery continues restricted in volume, makers now depending largely upon home demands, to which much more attention is directed by makers to compensate for the depressed condition of overseas' markets. At present production of semi products is improving, soft billets especially being in fairly active demand, while makers of cold rolled strip are also well employed. Market movements, however, indicate little variation of current steel prices which remain, on the whole, unchanged from last week's quotations.

Scrap.

Conditions in the markets for scrap metals continue unsettled, the only exception to general stagnation being a limited amount of buying at Sheffield, where there is a revival of demand for steel material for remelting purposes. On the North-East Coast the business passing in scrap is spasmodic, and does not amount to a great deal. There are a few openings for sheet scrap, but the works price of 60s. per ton is met by sellers' offers round about 62s. 6d. to 65s. delivered. Moderate parcels of steel turnings and cast-iron borings are changing hands at 45s. per ton. Other quotations are:—Heavy cast-iron machinery scrap in handy pieces, 79s. to 80s.; heavy wrought-iron scrap, bushelling and piling, nominal, 62s. 6d.; ditto, special heavy forge, 70s. to 75s. All delivered works.

Tinplates.

The market for tinplates continues steady, but business generally is quiet. Makers seem to have fairly well filled order books for 4-6 weeks ahead, and they are showing no anxiety to press sales for delivery beyond this. Spot lots are still wanted, and are commanding round about 19s. 9d to 20s. basis. Current quotations for the standard sizes rule:—Coke tins, IC 14 x 20, 112 sheets, 108 lbs., 19s. 6d. to 19s. 9d. per box; IC, 28 x 20, 112 sheets, 216 lbs., 39s. 3d. to 40s. per box, net cash, f.o.b. Wales. Terneplates.—18s. 6d. basis is generally quoted for usual lines, net, f.o.b. Wales, but there is not much business to be had. Makers are booked up to end August. The market for wasters is not too brisk at the moment. A moderate home trade demand is reported, but export orders have fallen off.

Metals.

Copper.—The market for standard copper during the past week has maintained its firmness, consequent upon the strength of New York prices for electrolytic, and partly to covering operations traceable to American interests. Consumptive demand on home account is also on an improving scale, but Continental business still leaves much to be desired owing to the disturbed conditions of European exchanges. France, however, is now buying more freely, and advices from the States indicating that the copper consuming industries there are operating on a larger scale justifies an optimistic outlook for the home market. Current quotations.—*Cash*: Wednesday, £63 3s. 9d.; Thursday, £63 5s.; Friday, £63; Monday, £63 1s. 3d.; Tuesday, £63 2s. 6d. *Three Months*: Wednesday, £63 11s. 3d.; Thursday, £63 13s. 9d.; Friday, £63 8s. 9d.; Monday, £63 8s. 9d.; Tuesday, £63 8s. 9d.

Tin.—In this section of the metal markets the tone continues consistently firm, the statistical position of standard tin being regarded as more satisfactory than was expected, the increase in visible supplies having been considerably less than had been anticipated. Consideration must, however, be given to the large unliquidated stocks in the East, which justify a certain degree of uncertainty, but with values at their present low level it is generally conceded that any serious setback in prices is hardly to be anticipated. Welsh tinplate works continue to absorb fair quantities of metal, but Continental inquiry is restricted and America is not displaying much interest. Much will depend on how things turn out in Europe and in America, since in both cases there are troubles of one sort or another which tend to make consumers cautious. Current quotations.—*Cash*: Wednesday, £153 7s. 6d.; Thursday, £153 2s. 6d.; Friday, £153 5s.; Monday, £153 12s. 6d.; Tuesday, £155 2s. 6d. *Three Months*: Wednesday, £154 3s. 9d.; Thursday, £153 15s.; Friday, £153 17s. 6d.; Monday, £154 7s. 6d.; Tuesday, £155 12s. 6d.

Spelter.—The market for this metal continues firm, with values again on the up-grade. Production is still restricted until accumulated stocks are reduced in bulk, but should some increase in demand materialise the position would speedily develop an improvement. Current quotations.—*Ordinary*: Wednesday, £28 5s.; Thursday, £28 10s.; Friday, £28 17s. 6d.; Monday, £29; Tuesday, £29 5s.

Lead.—Supplies of soft foreign pig are still limited in bulk, but with demand restricted values are a shade easier. The Continental demand shows a slight improvement, but home consumers are holding off the market. English lead is firm. Current quotations.—*Soft foreign (prompt)*: Wednesday, £25 2s. 6d.; Thursday, £25; Friday, £25 5s.; Monday, £25 10s.; Tuesday, £25 5s.

THE

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Contents.

	PAGE
Paris International Foundry Congress, 1923	87
Iron and Steel Institute	88
German Iron Foundries	88
Personal	88
An Apprenticeship Course in Foundry Practice.—III.	89
Some Notes on Foundry Organisation	92
A Study of Carburisation in the Manufacture of Synthetic Cast Iron	95
Obviating Contraction Strains	98
The Development and Manufacture of High-Tenacity Brass and Bronze	99
Manganese in India	101
American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product	102
Trade Talk	106
Correspondence	107
Gazette	107
Obituary	107
Iron and Steel Markets	108
Company News	15

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

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West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Paris International Foundry Congress, 1923.

The question of an international foundry congress and exhibition was carried a step further at a meeting of the Association Technique de Fonderie de France, held in Paris on July 20. M. Ramas, who presided, stated that he had been deeply impressed as to the great benefits to be derived from international gatherings by his recent visit to Birmingham. He and his committee had not allowed grass to grow under their feet since his return, and he was happy to announce that permission had been received from the Minister for Technical Education to hold a conference and exhibition at the Ecole des Arts et Metiers (Arts and Trades School) during the second week of September next year. The advantages of such a situation, he explained, were enormous, as it would allow of a centralisation not usually afforded. For the meetings there were halls and lecture theatres of all sizes suitable alike for accommodating the largest gatherings or a small sub-committee. There were several courtyards, the largest of which would be covered in to make a fine exhibition hall, and, finally, an excellent model foundry was part and parcel of the school, where competitions for moulding would be held, the difference between the Birmingham and the proposed organisation being that the castings and not the moulds would be judged.

It was decided that invitations be sent to the foundry technical associations of America, Belgium and Britain, not merely to send delegates, but actually to hold their conferences in Paris, the exceptional facilities of the place chosen making this quite simple. After thanking M. Ronceray for carrying through the negotiations with the Ministry, M. Ramas announced that this year's congress of the French Association would open on October 5 at Nancy, and would last three days.

Whilst we cannot at this early stage make much comment on the possibilities of British foundrymen actually fixing on Paris as their Conference centre, we certainly can say that the British foundry world as a whole will appreciate the kind invitation extended to their representative technical organisation. It may be profitable to point out that if only delegates can be sent that delegation should include some influential technical educationists, as the school chosen for the Congress represents a system well worth copying in at least five centres in Great Britain.

So well designed and equipped is this school foundry that it could compete more than favourably with most industrial establishments in this country. A large moulding bay is spanned by two overhead electrical travelling cranes of 3- and 6-tons lifting capacity. Metal is furnished by a 30-cwt. per hour cupola or by variously-operated crucible furnaces. The sand-preparing machinery has been carefully chosen, and is representative of the best practice, except, obviously, conveyors and similar means for labour-saving have not been incorporated. For drying the moulds, an oven, taking a bogey wagon mounted on rails, is provided. A separate stove for cores has been installed. Moulding machines of representative types, hygienic fettling benches, a modern sand blast cabinet, and other up-to-date apparatus complete the installation. At the side of the foundry a well-equipped pattern shop is housed, whilst in the open there is plenty of room for the storage of pig-iron and moulding boxes.

We understand that there are five such foundries in the technical schools of France, but perhaps not quite so well equipped.

To visit such a school is well worth the while of any foundryman who has apprenticeship and the associated question of the future of the foundry industry at heart. On these grounds one could wish that the invitation from the French Association could be accepted.

Lantern Slides for Engineering Lectures.—Messrs. Tangyes, Limited, Cornwall Works, Birmingham, announce that they have available for loan (free of charge) to engineering lecturers and technical instructors a large and varied selection of lantern slides of their manufactures, comprising gas engines, suction gas-producers, oil engines, steam and power pumps, hydraulic machinery, machine tools, etc.: also an assortment of slides of historical interest dealing with these subjects. A list of these slides will be sent free on application. There are also available for loan a number of Papers dealing with the different classes of machinery, to assist lecturers in preparing their own papers.

Iron and Steel Institute.

Autumn Meeting.

The Autumn Meeting of the Iron and Steel Institute will be held by kind permission of the Yorkshire Philosophical Society, in the Museum Theatre, York, on Tuesday and Wednesday, September 5th and 6th. The provisional programme of the Meeting is as follows:—

MONDAY, SEPTEMBER 4th.

The Secretary's Office will be open at the Museum of the Yorkshire Philosophical Society from 5 p.m. to 7.30 for the issue of badges and programmes and for the sale of railway tickets for the excursions to Staveley and Parkgate.

TUESDAY, SEPTEMBER 5th.

At 10 a.m. the Secretary's Office will be open for the registration of Members and the issue of badges, programmes, etc. At 11 a.m. the morning meeting will open for the reading and discussion of Papers in the Theatre of the Museum of the Yorkshire Philosophical Society. The Lord Mayor of York (Alderman W. H. Birch) will welcome the Members to York. Scrutineers will be appointed for the examination of voting papers for the election of new Members and Associates.

A selection of Papers will then be read and discussed, and the meeting will be adjourned until 2.15 p.m., when the reading and discussion of Papers will be resumed.

At 4.30 p.m. Members are invited by Mr. William McConway, of Pittsburgh, to attend a film demonstration in the Theatre Royal, York, descriptive of the new McConway process for the production of steel discs by centrifugal-hydraulic methods direct from molten steel. Light refreshments will kindly be provided by their host.

The evening will be left free for Members to make their own arrangements.

WEDNESDAY, SEPTEMBER, 6th.

At 11 a.m. the morning meeting will open for the reading and discussion of Papers in the Theatre of the Yorkshire Philosophical Society.

At 3 p.m. there will be a Garden Party in the grounds of the Yorkshire Philosophical Society. Music and light refreshments will be provided, and visits will be paid under the guidance of Dr. Walter E. Collinge (Keeper of the Museum) to the ruins of St. Mary's Abbey, York, and to the Roman Wall, the Multangular Tower, the Hospitium and other Roman mediæval and modern buildings in and around the beautiful grounds of the Society.

At 8.30 p.m. a Conversazione will be held in the Art Gallery of the City of York, followed by dancing, which will commence approximately at 9.30 p.m.

THURSDAY, SEPTEMBER 7th.

This day will be devoted to visiting, by kind invitation of Mr. C. P. Markham and the Directors of the Company, the Devonshire Works of the Staveley Coal and Iron Company, Limited, near Chesterfield.

At 7.45 p.m. for 8 p.m. Members will dine together informally in the Assembly Rooms, Blake Street, York.

FRIDAY, SEPTEMBER 8th.

This day will be devoted to visiting, by kind invitation to Mr. C. P. Markham and the Directors of the Company, the Works of the Parkgate Iron and Steel Company, Limited.

Papers to be Read at the Meeting.

The following is the list of Papers which it is expected will be submitted at the Meeting:—

The Changes of Volume of Steels During Heat Treatment. (I. Air Hardening Nickel Chromium Steels), by L. Aitchison.

Nitrogenisation of Iron and Steel by Sodium Nitrate, by L. E. Benson.

A Brinell Machine Attachment for Use with Small Specimens, by E. D. Campbell.

A Preliminary Magnetic Study of Some Heat-treated Carbon Steels, by E. D. Campbell and — Johnson.

Some Experiments on the Flow of Steels at a Low Red Heat, with a Note on the Scaling of Heated Steels, by J. H. S. Dickenson.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands, by C. W. H. Holmes.

Practical Notes on the Manufacture and Treatment of High-speed Steel, by H. K. Ogilvie.

The Bases of Modern Blast-Furnace Practice, by A. K. Reese.

Reversing Cogging Mills; Their Drives and Auxiliary Equipment, by G. A. V. Russell.

The Diminution of Lag at Arl through Deformation, by J. H. Whiteley.

German Iron Foundries.

The Association of German Iron Foundries (Foundry Union) of Düsseldorf reports that the activity of the foundries in the second quarter of 1922 was satisfactory in all parts of the country. Further large increase in the prices of raw materials and in wages and salaries had taken place. At the beginning of the quarter a certain amount of holding back was perceptible among customers in placing orders, but towards the end there was a brisk flow of orders. The foundries, however, were unable to develop their full output capacity owing to the growing scarcity of raw materials and the migration of workmen from the foundries, particularly into the building trades: and the places left vacant by them could only be filled partially by fugitives from Upper Silesia. Certain foreign countries were entirely out of the question for exports, as the import duties levied by them were higher than the German inland prices, and it was only possible to increase the exports materially to the East.

In the Western district the wage movements are assuming a more pronounced form. The degree of activity in the Saar is satisfactory upon the whole, and frequently good, and the supplies of pig-iron and coke are adequate. The wages there continue to increase, and as a consequence of the high costs of production the Saar foundries are more and more losing hold of the German market, causing them to seek trade abroad. The favourable situation in South Germany in the first three months was continued in the second quarter, this being attributed to the accumulation of orders during and after the strike. The wages paid in this district and in the West are the highest in Germany. In North and Central Germany the supplies of raw materials were less satisfactory, and continuous working was only maintained with difficulty, Northern Germany being more readily supplied with raw materials from England.

The Association states that it is doubtful whether the rate of activity in the coming months will be satisfactory, the principal question being the better and more regular delivery of raw materials. It is hinted that foreign pig-iron will provisionally have to be imported on a larger scale than hitherto.

Personal.

The late Mr. J. H. Osborne, of the Shanghai Dock & Engineering Company, Limited, left £4,385.

The late Mr. W. Lowe, managing director of Dean & Lowe, ironfounders and engineers, left £10,893 gross and £8,760 net.

Mr. A. Reichwald, of Reichwald, Limited, Finsbury Pavement House, E.C., who died on April 8, has left estate of the value of £46,325.

The late Mr. G. Wordsworth, of Thurgoland, near Sheffield, governing director of George Wordsworth & Sons, Limited, wire manufacturers, left £8,034.

The late Mr Edward Vaughan Morgan, of Messrs. Morgan Bros. and the Morgan Crucible Company, left estate of the gross value of £316,884, with net personalty of £315,831.

Mr. W. T. Bell, managing director, has been elected chairman of the board of directors of Robey & Company, Limited, Lincoln, in the place of the late Mr. Alexander Trotter.

Mr. D. M. Mackay, a director and manager of Messrs. David Colville & Sons, Limited, of Motherwell, a director of the Clyde Alloy Steel Company, Limited, and of Smith & Maclean, Limited, left personal estate in the United Kingdom valued at £107,056.

An Apprenticeship Course in Foundry Practice.—III.

By Ben Shaw and James Edgar.

(*Continued from page 71.*)

Stacking Timber.

In a previous article the statement was made that it is too often forgotten, by patternmakers, that timber is stacked or racked to season it. It is always difficult to get journeymen, as well as apprentices, to realise the importance of replacing boards in the racks after they have sawn off required lengths. Broadly speaking, there are three methods of storing timber. It may be stacked in an almost vertical position, as shewn in Fig. 1; racks may be made to support the timber resting on edge, as shewn in Fig. 2; or the boards may be placed on top of each other, like Fig. 3. In small shops it is a common custom to store the timber in a corner of the shop. If it is kept in the open air, then it should undoubtedly be stacked as in Fig. 1, and the short lengths put in special racks in the pattern shop. This form of timber stack is usually erected outside but within convenient reach of the pattern shop. The rack should be covered, the roof being supported on columns leaving the sides and ends open, and it should be located over a prepared cinder bed to ensure drainage.

The rack, consisting of four frames placed about three feet apart and tied together, is a very satisfactory method of keeping timber that is already comparatively well seasoned. A rack like this does not occupy more space than placing the boards on top of each other, and, if sections are allotted to different thicknesses, both time and labour is saved. When timber is stored as shewn in Fig. 3, strips are placed between the boards in order to allow air to circulate about them, and thus complete the seasoning. The objection to this method, however, is that it takes up much space, and that, even if different thicknesses are filed separately, it may be necessary to turn over many boards before a satisfactory one, for the purpose required, is obtained.

Plywood.

Plywood is not greatly used in pattern shops. The only purpose for which it might be used is for making ribs, either for patterns or core-boxes, but it is inadvisable to use it, even for this purpose, because, when the work comes into contact with the damp sand, the glue invariably softens and the layers of timber come apart. In some shops it is used for drawing boards, and it is, within limits, suitable for the purpose. It is light, therefore easily handled, which is an advantage with large boards, and, as only hardwood is obtainable as plywood, a neat drawing is obtained. The disadvantages are that care must be taken that such drawing boards must not be left in foundry yards —no drawing board should be for that matter— nor must they be left adjacent to foundry stoves; another disadvantage is that it is not possible, as with an ordinary drawing board, to unscrew the battens, take the board to pieces and clean off an old drawing board at the planing machine.

Glue.

The preparation and use of glue deserves more attention than is given to it in most pattern shops. Glue should always be regarded as a necessary evil. It should never be used unless patterns are to be painted and varnished; indeed, in all but very exceptional cases, its use should be regarded as a temporary expedient to hold the work together while being turned or carved. Good-quality glue is essential for patternmaking. Very little fish glue is used for this purpose. The best known glues are obtained from hides, but bones and other animal skins provide glue. Glue has also been manufactured recently from leather waste. Its desirable characteristics are:—(1) Strong adhesiveness; (2) tenacity, which is slightly different from adhesiveness, and which may be defined as the power to resist the disruptive effect of a stress in any direction. This, however, is not as important in patternmaking as in aircraft construction. (3) Elasticity or the power to stretch slightly without fracture; and (4) it should possess practical working qualities.

Thick shellac varnish is occasionally used as an adhesive for broken corners, affixing brass letters, and small leather fillets. It may be stated, as a general rule, that animal glue in sheet or flake form is practically the only glue used in the pattern shop. There are patent liquid glues on the market which are very satisfactory, but they are not used for general work, because of the cost. The best results are not obtained from glue which is boiled directly after it is broken up. The proper way to prepare it is to break the cakes into small pieces, then put a quantity into a soaking pot full of cold water. With ground glue, which is seldom used in pattern shops, a soaking of 15 to 20 minutes is sufficient; flake glue needs 10 or 12 hours; while thick cake glue is not injured by 24 hours' soaking. It is bad practice to keep a large quantity steeping and simply replenish as some is taken out of the soaking pot. Burnt glue should always be thrown away, as its adhesive power is impaired. It should also be remembered that glue is strongest when freshly prepared, therefore it is better, when only a small quantity of it is used, to keep a glue pot half full; this also ensures it being clean. In a large shop three or four pots should be kept hot in the steam chest, with a spare pot full of clean hot water. Too high a temperature spoils glue. It should be heated to approximately 140 deg. Fah. (60 deg. C.), and it ought always to be used when hot.

Glueing work is never satisfactory in a cold or damp workshop. The faces of timber to be glued should, if the shop is cold, be warmed to prevent the glue chilling. For end grain thick glue is necessary, and a preliminary sizing coat is an advantage, but glue of a thin consistency is best for most purposes. Many factors enter into glueing. Surfaces should be dusted before the glue is spread, glass paper should never be used to scratch the surfaces, as this fills the pores, and, for the same reason, chalk should not be used when forming joints. All joints should be "rubbed," that is, the superfluous glue and air should be pressed out of them, but care should be taken not to overdo the rubbing. Both faces of a joint should be spread with glue, and it is advisable to leave glued work for 10 or 12 hours before placing a strain upon it.

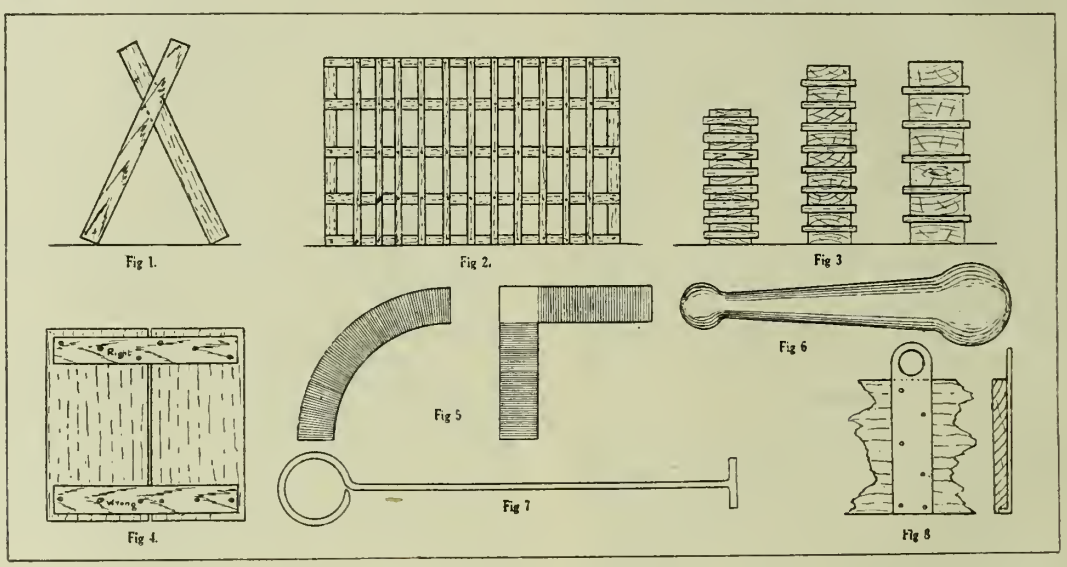
Brushes should not be left in the glue. A good joint cannot be made with a brush which is shedding hair, and, to prevent this, and prolong the life of the brush, it should be allowed to soak in clean water when not in use. Finally, it should always be remembered that it is futile to glue wet timber, to use burnt glue, or thick and cold glue, which simply forms a layer between the two timber faces.

Nails and Screws.

There is an increasing prejudice against the use of nails in some shops, but the practice in other shops of not using them for any purpose whatever is just as foolish. Wire nails and sprigs are satisfactory for segmental work, for fastening ribs, and many small facings and bosses. Care should always be taken to dovetail, unless it is impossible because of the thinness of the work. With regard to "grip"—we are using workshop terms—this depends on the thickness of timber and on the length of nails being used. When fastening down $\frac{1}{2}$ in. timber, sprigs $1\frac{1}{4}$ in. long should be used; but if the timber is $1\frac{1}{2}$ in. thick, nails $2\frac{1}{2}$ in. long would, in most cases, suffice. In all cases sprigs and other driving nails should be punched down. Oval wire nails are more satisfactory for most purposes than flat-headed nails. Some patternshops— very few, fortunately—use wire nails largely for core-box construction and "clinch" them; that is, if the two thicknesses to be fastened together make 2 in., longer nails are driven through and the ends knocked over. This is not only a clumsy job, but seldom satisfactory. The use of panel and veneer pins are particularly suitable for small intricate work.

As a general rule, screws, though less economical

than nails, are preferred, not only because they give better security, but because they can easily be removed when they come in the way of tool operations and when the pattern needs to be altered. With regard to the "grip" of screws $\frac{1}{2}$ in. is sufficient, excepting when the screw is over $2\frac{1}{2}$ in. long, and then $\frac{3}{4}$ in. should be allowed, and, in very large sizes, 1 in. Screws are seldom satisfactory for end grain, but nails are a bad substitute; this is one of the difficulties with which patternmakers have to contend, that may, on occasion, be overcome by skilful construction. When using screws, the holes in the top thickness should always be bored to allow the screws to be pushed through without the aid of a hammer. Under no circumstances should screws be hammered through the top thickness; the fibre is, in this way, bruised, and if the timber does not split at the time it may ultimately do so. Screw heads should be flush with the surface of the wood, or very little under, excepting when the screw is to be removed by the moulder; then a cheese-headed screw, with the head partly projecting from the work, is preferable. It is not good practice to insert screws a short distance apart, and on the same "line" of the grain. Fig. 4 illustrates the correct way of screwing battens on a board, and this method is applicable for much other work.



Paint and Varnish.

There are a number of patent lacquers and enamels on the market now specially prepared for the patternmaker, but some do not give satisfaction, therefore, many still prefer to mix paint and varnish for themselves. Many of these special varnishes are made from ordinary varnish gums which are not available for patterns. What is required is a genuine shellac varnish without the admixture of gums or quick driers. Some firms do supply a reliable varnish of this description. These varnishes are superior to those made in the shops, because they are filtered and they have time to mature, and there is no waste of time and material in their preparation. Red-lead paint is invariably used on medium-sized and sometimes on large work, and the coated surfaces are afterwards varnished. Some books on patternmaking mention copal varnish, but it is very seldom indeed that it is seen in the pattern shop. It dries very hard and is very satisfactory, but it takes too long to dry. Shellac varnish is invariably used, and it is a thoroughly satisfactory protective coating. It should be remembered that the object of coating patterns is not merely to give them a smooth and glossy finish, to facilitate withdrawal from the sand, but to protect them from the varying temperature conditions of the foundry and to cover glued joints. The best flaked orange shellac dissolved in methylated spirits makes a reliable varnish. The shellac should be just covered with spirit and allowed to dissolve. The varnish pot should always be covered, and if the varnish becomes dirty a little oxalic acid will clarify it. Some pattern shops paint core-prints and machined surfaces in special colours. For this purpose colouring matter is introduced into the varnish, either lamp-black, drop-black, or aniline black being used for black varnish; orange lead, vermilionette, or Bergen's vermilion for red varnish. These are the colours most commonly used, but pigments or aniline dyes can be obtained for any colour desired. Some patternmakers use the coloured varnish for distinguishing between the metals of which the castings are to be composed; it reduces the possibility of error at the foundry. Varnish should be applied sparingly with a soft brush. Two or three coats are necessary, and the varnish is better thin than thick. The surface should be sandpapered smooth after each coat.

Fillets.

Fillets are necessary on patterns to prevent irregular crystallisation of the metal in the castings. When drawings are supplied with sharp corners the patternmaker or moulder rounds and fillets, unless it is specially desired that a corner be cast sharp, knowing from practical experience that it reduces the tendency to fracture. Sharp corners also tear the mould and prevent the easy delivery of the pattern. The crystals form at right angles to the face of the mould, and when the junction between pieces, at an angle to each other, is filleted, a stronger casting results than is likely when the corner is made sharp. Fig. 5 shows clearly what is meant. Fillets are best cut from the pattern block. Wood fillets are better than lead; they are made in straight lengths, and are only suitable for straight work. They should be glued, sprigged and afterwards well sand-papered. Wax fillets are quite good, but leather fillets are undoubtedly the best loose fillets. When properly fastened with glue of medium consistency and the surface rubbed with a dumbbell tool like that shown in Fig. 6, a very satisfactory job results. Leather fillets can be used on concave and convex surfaces. No nails should be used, but, if the pattern is not to be varnished, it is necessary that it should be sprigged, otherwise it will curl off in the damp sand.

Use of Glasspaper.

Too much glasspaper is used in pattern shops. For irregular surfaces it is almost indispensable, but it should not be used on planed surfaces, as, even if a good rubber is used, it renders level surfaces uneven. Under no circumstances should sandpaper be used to grind work to shape, as accuracy cannot be attained in this way. Apprentices—and journeymen—use sandpaper when turning, very often, as a substitute for sharp tools.

Lead Rivets.

Rivets made of lead have a very real value in the pattern shop. They are used for securing the joints of thin framed work, and also when thin plates are required in two thicknesses. They are used in preference to screws when the grip of the screws would be so small as to render them almost valueless. The rivets are made from lead wire from $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter. Holes are bored and countersunk on each side, pieces of wire a little

longer than the thickness of the two pieces of wood are introduced and riveted. These rivets can afterwards be planed with the wood without any apparent effect upon the blade.

Rapping and Drawing Plates.

A great deal could be written about pattern-drawing methods, which are equally the concern of the patternmaker and the moulder. All but the smallest patterns should be fitted with plates, otherwise the moulder has no alternative but to hammer a spike into them, which is a very destructive practice. A point to be considered in locating drawing plates is that when the pattern is suspended from them, it balances. It is well to bore holes in the pattern underneath the holes in the plate, but larger, so that no harm can be done when the lifting or rapping rod is inserted. For deep lifts the plates should, if possible, be set into the underside of the pattern or the plate screws may strip. Plates usually have one hole screwed for the lifting rod, and the other drilled for rapping. For very large work a keyed end on the lifting rod is sometimes substituted for a screw, as in Fig. 7. The plate for this rod has a rectangular hole through the centre, and, when the rod is inserted, only a quarter turn is necessary to take hold. With small patterns the lifting rod is sometimes used for rapping, but this rapidly destroys the thread. When the pattern is to be deep in the sand, and its thickness prevents the use of a lifting rod, lifting straps, such as is shown in Fig. 8, should be attached before the pattern leaves the pattern shop. These are usually made from hoop iron from 1½ in. to 2 in. wide and from ⅛ in. to ¼ in. thick.

Dowels.

Dowels may be made of wood or metal. If made of wood, they should not be more than ½ in. or ⅝ in. long and shorter for ¼ in. and ⅜ in. dowels, and they ought to be tapered almost from the face of the pattern. They should not be "tight" when the top half of the pattern is placed in position, nor yet should they be slack. The objections to wooden dowels are that they swell and invite the attention of the moulder's pocket knife, and the holes became filled with sand, which is not easily removed without damaging the hole. Wooden dowels should be made of hardwood. Metal dowels are coming more into general use, these being made of brass or iron. Both socket and dowel are usually tapped or screwed into holes bored in the parts, thus, for small work they are more suitable than iron plate dowels. Plate dowels are made rectangular, circular, and, what may be termed double circular, and in various sizes. A point in their favour is that they never get loose.

Pattern Letters and Figures.

These are made in Roman and Gothic styles. The "Maughlan" letters, which were shown in this journal a few months ago, are very satisfactory. Small letters may be fastened with shellac and larger ones with nails. In some shops lead letters are cast as required in iron moulds. Roman letters are bolder, but the sharp Gothic give less trouble to the moulder as they leave the sand readily. For fastening small brass letters, burnt shellac is the best adhesive; it is made by burning the spirit out of shellac varnish. Incidentally, this adhesive is very suitable for patching small corners broken from patterns.

Metal for Patterns.

The use of metal in the formation of patterns has considerably increased during recent years, especially for standardised work. Very complicated designs can be satisfactorily formed in metal: it maintains its shape better than wood, and ensures a cleaner withdrawal from the sand. It is only suitable when very large quantities of castings are required however, and when there is no possibility of alterations. Quite a variety of metals are used, depending upon the shop methods. Iron, brass, bronze and white metals are used. Close grained grey iron, such as is used for light machinery castings, is very suitable. To prepare iron patterns for moulding, they should be rubbed over with a sal-ammoniac solution and allowed to dry. After being thoroughly rusted a wire brush is applied vigorously over the surface, and a coating of wax applied. To do this the pattern is heated, the wax warmed, and the coating put on with a soft brush; the surface being afterwards smoothed. Sometimes when a wood pattern is sent to a foundry from which many castings have to be made quickly, a few iron patterns are cast. This practice is only possible with small and comparatively rough work, because of contraction difficulties. An alloy of equal parts of tin and zinc has small shrinkage, about $\frac{1}{16}$ in. to the foot, and is therefore very suitable for work like this. A harder alloy consists of 85 per cent. tin and 15 per cent. antimony. Aluminium patterns are used considerably for internal combustion engine work.

Wire.

A description of patternmaking materials would not be complete without some mention of wire. On some patterns many ribs, and other parts, have to be left "loose," that is, located in their correct positions firmly, yet so that they can be left in the sand, when the moulder draws the main part of the pattern. Sliding dovetails form the best temporary fastenings, but, when it is not practically possible, or, when one or two only are required, wire, sprigs, or screws are employed. Sprigs are objectionable because of the difficulty in withdrawing them, and screws are only suitable when the "loose" part is so situated that the moulder can use a screw-driver freely, after sand has been tucked round the part, and there is no danger of it being moved. Wire is most serviceable, because a suitable hole must be made previous to its insertion, and also because a grip can be made at the end. Copper wire is best, and the gauge should depend on the size of the work. When all is said that can be said for wire sprigs and screws, they should only be regarded as unavoidable makeshifts, and bad substitutes for dovetails. Sometimes loose pieces can be checked into the main body of the pattern or the core-box, and this alone suffices, and, occasionally dowels answer the purpose. Dowels are very satisfactory.

Other Materials for Pattern-making.—Although metal patterns are frequently made, the patternmaker is essentially a woodworker, but there are also other materials of which patterns are sometimes made. We need not mention sand patterns here, but rubber is sometimes, although very seldom, used for small patterns. Plaster of Paris is largely used in the light casting industry, but not very frequently in engine shops, and of lead the same may be said. Some pattern-makers have sought to use sawdust by mixing it with plaster of Paris or other cement, such "artificial" woods not usually proving economical, even if comparatively successful. A new proprietary article has recently been placed on the market which is, within limits, a very useful material in the pattern shop. We refer to "Necol" plastic wood. It is a material having a consistency like dough, and can be moulded into any form, drying hard when exposed to the air—a sort of artificial wood without grain. We do not think it will ever be much used for pattern construction, but it is useful for filling holes, forming fillets, and making up broken corners. When old castings are used as patterns, making-up pieces for machining and contraction have either to be fastened to the old casting or supplied to the moulder to bed into the mould, and plastic wood has proved very successful for this work, as it adheres to metal surfaces equally as firmly as to wood.

Dealing with the future trade position at the meeting of Vickers, Limited, Mr. Douglas Vickers, M.P., analysed the position of the investor. Engineering products, he pointed out, were purchased almost entirely on capital account, and paid for either out of profits retained in the business or sums raised by new capital. While excessive taxation had almost put a stop to the former there was little attraction to investors to put money in plant at present prices in view of the return obtainable on trustee securities. Mr. Vickers suggested that advantage could be taken of the attitude of the investor by granting a Government guarantee to loans raised for developing the Empire overseas.

Some Notes on Foundry Organisation.

By H. W. Ross.

The installation of foundry equipment must be backed by good administrative services, the close association between these two points is not generally accepted, hence one often finds new plant put to work under unfavourable conditions and giving results far below those rightly claimed by the manufacturers.

It is essential that the work is fed to machine and hand operations in a predetermined and systematic manner, and, to attain this, orders and instructions must be issued to all departments, giving all requisite information, so that work can be planned out and delays eliminated.

A further important point is the number of hours per day that such machines can be kept producing. "Waiting time" must be kept down to a minimum. This source of loss is always a serious item in a foundry and is most ably described in detail in "Maximum Production in Shop and Foundry," by Knoeppel.

It is not suggested that the methods described in this article will cut out the loss of "waiting time," or be applicable to any foundry; local conditions must always be taken into consideration. It is, however, hoped that it will materially assist those foundrymen who have experienced difficulty in the issuing of orders, controlling work in the shops, ability to make promises of delivery upon which clients can rely.

A further consideration is that of costs, in which foundrymen are vitally interested. To enable the cost office to carry out their duties, it is necessary that they are closely linked up with the foundry, and it will be noticed that the methods under review cater for this in various ways.

The conditions found in the foundry where this system worked, called for the classification of all orders into trade groups, which represented the class of work, for which cost accounts were kept and compared from time to time. These groups were coded for reference purposes, as under:—

Automobile	S.A.
Engineering—plain	S.E.
,, medium	S.G.
,, intricate	S.H.
Railway	S.R.
Patterns—chargeable	S.P.

Series of numbers were also allotted to each group so that when orders were filed in numerical sequence the division by groups was automatically obtained

The classification of orders received must, of course, be undertaken by a practical man, for preference the foundry manager, who would affix to the customer's order a slip, as "Form A," and fill in the code group and information relating to patterns.

The customer's order, together with the "Information Slip" (Form A), is then passed to the Order Department, who enter it on a "Daily Report of Orders Received" (Form B). This report is made out in duplicate, a separate report being used for each group. Consecutive numbers are allotted to each item of a customer's order; this latter rule may appear to be unnecessary or extravagant, but after having seen several other systems it was decided that this method was the only practical one to give the desired results under the conditions existing. One copy of this report is filed in an Order Register, thus acting as a direct reference to client's name by Order Number. The duplicate is passed to the foundry office, who fill in estimated weight, price, and value. These are summarised daily, so that the accumulative totals of both weight and value is always obtainable. Such information should always be charted, showing accumulative totals, comparisons between this month, last month, this year, last year, and will be of great value to both the sales and foundry managers.

From the customer's original order, the Order Department type Sales and Production Order sets (Form C), separate sets being used for each order number, i.e., each item of a customer's order.

Any alterations made after the issue of such sets, such as price, quantity, delivery instructions, should be advised to all departments by the circulation of additional sets under the same group and order number; such sets should be distinctly stamped "*rectification only.*"

Sales Orders.

These consisted of copies for: (*a*) Order department; (*b*) cost department; (*c*) despatch department; (*d*) accounts department.

(a) *Order Department.* This copy is filed vertically under client's name, thus forming a cross-reference to the order register.

(b) *Cost Department.* This is filed numerically, *i.e.*, under groups, and used where necessary for opening up job cost accounts and general reference purposes.

ORDER DEPT. INFORMATION SLIP.

CLIENT:

CODE:

GROUP:

Patterns to be—

Altered / Made / Purchased } and charged to Clients.

REMARKS:

FORM "A."

(*c*) *Despatch Department.* This is filed in a box file, in alphabetical order, representing "Orders on Hand." All deliveries are recorded on the back of this copy, showing:—

Date—Advice No.—Quantity—Accumulative Total.

As the total quantity called for is despatched, these copies are transferred to an "Order Completed" file for future reference.

(d) *Accounts Department.* This is filed numerically, representing "Orders on Hand." As invoices are made out from the Advice Notes, particulars as to prices, terms, etc., are obtained

DAILY REPORT OF ORDERS RECEIVED.

Class Date

S. O. No.	Client.	Weight.	Rate.	Value.

FORM "B."

from this copy of the order, and the following information entered on the back:—

Date—Invoice No.—Quantity—Weight.

In a similar manner to copy (c) which are transferred to a completed order file.

Provided all invoices are made out to date, the Orders on Hand of the despatch department should agree with those of the accounts department, and this check should be done monthly.

Production Orders.

These consisted of copies for: (*e*) Pattern shop; (*f*) foundry office; (*g*) moulding department; (*h*) inspection department.

(e) *Pattern Shop.* This copy is only a requisition to the pattern stores to supply the moulding department with the necessary patterns and core-boxes. The receipt of such does not act as author-

ity for the making or alteration of patterns, this being catered for by: (a) Issue of a special set of orders for all work chargeable; (b) verbal instructions at a daily meeting held by foundry manager in the case of alterations chargeable against the foundry.

The patterns were labelled with the production order number and delivered to the moulding department, and this copy of the order sent to foundry office, thereby automatically advising the latter of orders ready for production.

(f) *Foundry Office.* This is the master order record of the foundry and is filed on receipt alphabetically. On receipt of (copy *e*) from pattern shop, the date of receipt is recorded on the back;

As the pattern shop copy is received, the moulding department copy of the same order is transferred to a "*Work in Hand*" file and passed to the foreman, who uses this for issuing work to the shops. This copy is arranged to record moulder's check number, date and quantity moulded.

(h) *Inspection Department.* This copy is issued direct to the inspection department for informing them of any specific tests to be carried out, and provide necessary data for making out inspection reports.

Patterns Chargeable.

A common difficulty experienced in the foundry is charging out new patterns or pattern altera-

Accounts Dept. Copy. No. 11		SALES ORDER.			TO BE FILED NUMERICALLY.	
Client's Order No.	L. O. Ref.	Client			Cost Symbol	Order No.
Client's Drg. No.	Date Retd.				Order Comprises	Date
Pattern No.	Core Box No.	Terms	Carriage	Patt. Retd. (Date)	Advice No.	Quotation No.
Quantity	Description				Remarks	
Delivery Required						
Delivery Instructions						
	Price					

Foundry Office Copy. No. 12		PRODUCTION ORDER.	TO BE FILED FIRST NUMERICALLY AND AFTER TRANSFERRED UNDER CLIENT'S NAME.	
Client's Order No.	Drawing No.	Client	Cost Symbol	Order No.
Pattern No.	Core Box No.		Order Comprises	Date
Quantity	Description		Quotation No.	
			Delivery Promised	
Tests Required				

Form "C."

also the following information obtained during the progress of the order from daily reports:—

Date—Heat No.—Quantity Cast—No. Scrap—Accumulative Total of Good.

No. Scrap on Inspection—Nos. Welded—Nos. for Recast.

Supplementary Orders Issued, No. and Date.

Nos. Delivered to Despatch—Unit Weight.

The routine of the foundry office, in addition to the above, is briefly (1) to issue to foreman moulder (copy *g*), referred to later, on receipt of pattern shop (copy *e*), thus advising that the job is ready to be put in hand (2) to enter on foundry office copy records of all quantities cast, and whether scrap or good; (3) to enter all castings scrapped by the inspection department and numbers passed through for despatch; (4) to issue supplementary orders for all castings required to replace shop scrap.

(g) *Moulding Department.* This copy is sent direct to foundry office and filed by them for the use of the foreman moulder, who is thus advised of work coming along, and can consult with the pattern shop regarding any alteration in methods of manufacture.

tions, which are often retained by the foundry against future orders, and consequently do not pass through the despatch department. To cater for this, a separate set of Sales and Production Orders can be issued for all new patterns or alterations chargeable. These are similar to Form C, except that no copy is sent to the inspection department.

The sales orders are treated in a similar manner to that previously described, except in the case of the despatch department, who retain the copy until the castings ordered in connection with the pattern had been despatched. In such a case the copy of the pattern order is transferred to a file for "Patterns for Despatch." This file was periodically gone through by the foundry manager, and, where considered necessary, instructions are issued for their return to customer.

Production Orders.

The pattern shop copy is this department's authority for proceeding with the work, and when completed is sent to the foundry office together with the copy of order for the castings required from such pattern. On receipt of these two copies the foundry office sends the former direct to the

accounts department, and the latter is treated as previously described under the heading of (f) *Foundry Office*. By such means the accounts department are able to pass charges through the books, holding up the actual invoice until a consignment of castings is invoiced. The copies for foundry office and moulding department are filed with the order for castings, thus intimating by their presence the reason of delay.

Delivery Promises.

The orders in hand, as shown by the foundry office copies, are examined daily, and in the majority of cases a promise for delivery settled at the daily meeting, whether requested by customer or not. The information so obtained is recorded on "Form D," copies being sent to (*a*) the secretary, who in this case advises customers when necessary; (*b*) the despatch department, who advise the foundry manager direct when the delivery promised is not adhered to. The original copy is retained by the foundry office, which has the information charted so as to enable all concerned to see at a glance what castings are due from day to day. The chart referred to is of very simple construction, being a ruled tracing from which prints were obtained showing: *Production Order Number, Quantity Ordered, Pattern Number,* and the quantity promised shown in columns under the date due.

DELIVERY PROMISE SHEET.

To	Clients to be / not to be Advised.	Date	Date Promised
Secretary / Despatch Dept. / Foundry Office			

S. O. No.	Clients' O/No.	Clients.	Quan.	Description.

Instructions—
(a) Secretary to advise clients if required.
(b) Despatch Dept. to return to Production Engineer if promise is not kept.
(c) Foundry Office to record promise on chart.

P.E. Signature.

Form "D."

By this means it will be found that, except for causes beyond control, such as castings rejected on inspection, complaints of non-delivery to time will be a rare occurrence. Moreover, the chart is of great assistance in determining delivery dates, as one can see at a glance what is ahead. When orders are overdue, a fresh date is decided on, and a large coloured pin inserted in the board, in the square on which the original date fell, so that the number of days overdue on any order can be determined.

Progress.

The system of progressing is instituted solely to benefit the moulding and coremaking departments, as overcasts are often frequent. This is performed by the use of a board hung in the shops showing: (*a*) Orders available, *i.e.*, those for which the foundry office had received an advice from the pattern stores; (*b*) numbers cast in each heat showing the dates and heat numbers; (*c*) accumulative total cast. These records are made by the foundry office immediately after each heat. Such a system could, of course, be extended to cater for all operations, but its real value should naturally be considered in conjunction with the cost. In the present instance the value is in stopping overcasts, and the slight clerical cost was undoubtedly justified.

Replacements.

As mentioned, supplementary orders are issued for the replacement of shop scrap, quantities being recorded on the back of the foundry office copy from which these orders were issued.

In the case of returns by customers, special forms are used, on which are recorded particulars of such returns. These accompany the castings to the inspection department and the decision of the inspector added thereto. On completion of inspection, the form is sent to the order department, who, from the particulars outlined, issue a separate Sales and Production Order set, thereby treating such replacements as new orders and enabling the cost department to collect data as to the cost of such work.

From the foregoing it will be seen that the following information is easily obtainable: (1) Daily value and tonnage of orders received; (2) daily value and tonnage of orders despatched; (3) orders held up for the making of patterns; (4) orders held up, but for which patterns were in existence; (5) orders available for work; (6) orders completed under trade groups; (7) orders issued to replace shop scrap, so that costs are obtainable of replacements; (8) visible record of orders promised and overdue; (9) visible record of numbers cast off each pattern; (10) visible records of work available, but not in production.

In addition to the above, a check can be made of all despatches and invoices whether for goods actually delivered or charges incurred in pattern-making.

The duties and responsibilities of a foundry manager are so numerous, entailing so much attention to the technique of the trade, that his clerical work is often neglected or performed by an assistant with very little, if any, real knowledge of administration. Consequently, the records, which may be vital to the manager when making quick decisions, are useless to him. Hence, in many cases, such decisions are made from practical experience instead of actual facts.

Societe Normandy de Metallurgie.

It appears from further reports that although a liquidator has been appointed the liquidation of this company is more in the nature of a voluntary than a compulsory one, to enable a reduction of capital to be effected. No change will take place in respect of the personnel or continuity of the works, which are continuing to operate.

The company unfortunately suffers from having been constructed between 1917 and 1920, when costs were very high, and having started to make steel just as the trade depression was gathering force, and, further, the company has not the advantage of reserves accumulated through high profits during the war period, and under these circumstances a scaling down of the capital is necessary. It is necessary to distinguish between the Société Normande and the firm of Messrs. Schneiders, to whom it is affiliated, who have helped the concern very materially in the past; but of course this is only one of their many subsidiaries, all of which cannot be carried indefinitely in a period of unexampled depression.

Mr. Mark Firth, son of the chairman of Thomas Firth & Sons, Limited, who is about to be married, has been the recipient of a presentation from the managers, staff and foremen of the company as a token of their esteem and goodwill. Mr. H. Newbould made the presentation.

A Study of Carburisation in the Manufacture of Synthetic Cast-Iron.*

By Clyde E. Williams and C. E. Sims.

(*Continued from page* 62.)

The temperature of the bath of metal was taken at intervals throughout each run. A Leeds-Northrup optical pyrometer was used, two readings being taken by sighting first upon freshly-exposed metal and next upon the carburiser. These two readings compared very closely. The temperature was maintained fairly constant throughout all of the runs. It ranged between 1,350 and 1,450 deg. C., and was seldom higher or lower. Integrated temperatures for the various runs were not usually more than 50 deg. apart.

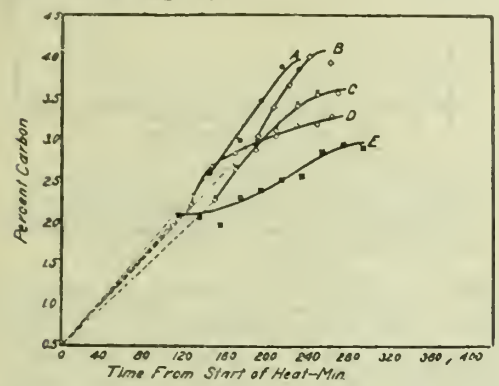


Fig. 1.

Showing the rate of carbon absorption when using different forms of carbon. Silicon content about 2 per cent. in each case; other impurities low.
A=Coal-tar coke. B=Graphite. C=Low-ash coke, containing 13 per cent. ash. D=Charcoal. E=High ash coke, containing 25 per cent. ash.

The experiments performed in the 50-lb. furnace were repeated in the 300-lb. furnace. In all, seventy-eight individual melts were made. Conclusions have been drawn from the results obtained in all of these tests. All the data cannot be reproduced here, and, therefore, only results of the typical runs will be shown.

The curves in Fig. 1 show the rates at which different forms of carbon are absorbed in molten iron and the relative values of these varieties of carbon as carburisers. The dotted portion of any curve is indefinite and covers the melting period.

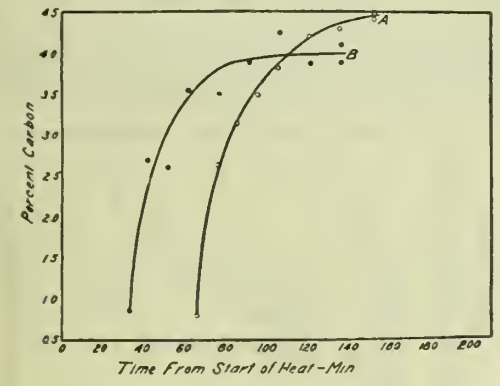


Fig. 2.

A=Using graphite as carburiser. B=Using charcoal as carburiser.
Showing the rate of carbon absorption at the lower concentrations of carbon. Tests made in small furnace on iron containing 2 per cent. Si.

The carburisation between 0.5 and 2.5 per cent. carbon has been largely ignored in this investigation for the reason that, throughout this range, absorption is so rapid that no appreciable difference in the various materials could be found. This is illustrated in Fig. 2. In these runs the metal was melted in the absence of carbon and then graphite and charcoal, respectively, were introduced. In each case the carbon in the iron increased from 0.8 per cent. to 2.7 per cent. within 10 minutes. Keller states that the carburisation of molten iron is very slow as compared with that of small solid particles of iron such as turnings. The tests just described and other similar ones show that the rate of solution of carbon in molten iron is rapid, but naturally diminishes as the saturation point is approached. Furthermore, observations seem to indicate that carburisation during the melting-down period is accomplished, not in the solid iron phase as intimated by Keller, but in the liquid iron as it gradually forms and mixes with the carbon which at first is present in large excess. Results in the experiments here described have shown that there is little difference in the amount of carbon introduced whether melting small steel turnings or comparatively large boiler-plate clippings. The extreme slowness of the penetration of carbon in the cementation process is well known. It is, therefore, very probable that in making synthetic cast iron most of the carburisation takes place after the steel has melted.

Comparison of the Different Varieties of Carbon.

Graphite.—Acheson granular resistor graphite was used in the tests. Graphite always gave a rapid rate and a high degree of carburisation, in practically every case excelling all the other forms of carbon. The superiority of graphite over granular resistor carbon or coal-tar coke, which is similar to petroleum coke, was not very great. Curve B, Fig. 1, shows the carburisation curve for graphite. The steep pitch of the curve and the high percentage of carbon obtained are particularly noticeable. The high apparent density of graphite undoubtedly assists it in obtaining good contact with the metal; its low ash content also unquestionably improves its carburising power as will later be brought out more fully.

Charcoal.—Curve D, Fig. 1, shows the rate of carburisation using charcoal in the large furnace. Much lower absorption of carbon is shown here than in the charcoal curve in Fig. 2, which was obtained from a test in the small pit furnace. There was much better contact between the charcoal and the metal in the small furnace than in the large one. All the tests have shown that good carburisation is possible only when good contact between the charcoal and the metal is obtained. Because of the light, porous nature of charcoal there is much difficulty in keeping it in good contact with the molten iron, especially near the arc or in the presence of a slag. The layer of charcoal on the bath should not be so thick as to prevent the arc from penetrating to the metal. In some types of furnaces, notably the pit-type furnace working continuously, charcoal should give satisfactory results.

Coal-tar Coke and Granular Resistor Carbon.—The coal-tar coke, made by the distillation of coal tar, was obtained from a local creosoting plant, and contains from 7 to 8 per cent. volatile matter and less than 4 per cent. ash. It is similar to petroleum coke and any reference made to it should apply with equal weight to petroleum coke. Curve A, Fig. 1, shows that coal-tar coke gives excellent carburisation, more nearly approaching graphite than anything else that has been used. Fig. 3 shows a comparison of coal-tar coke with some other cokes. Granular resistor carbon containing 5 per cent. ash has given results similar to those obtained with the coal-tar coke.

High-ash Coke.—During the early experiments a high-ash coke was used for carburising with consistently poor results, the maximum carbon content obtained in the iron being a little over 3 per cent. This coke was so noticeably inferior that an investigation of the reason was undertaken. Analysis showed that the coke contained 25 per cent. ash, and it was suspected that the trouble was due to this high ash content. Further experiments unquestionably proved that the high ash was the cause of the inferiority of the coke. A coke containing 13 per cent. ash gave much better carburisation than did the 25 per cent. ash coke.

*A Paper read before the American Electro-chemical Society.

but poorer carburisation than did the lower ash coal-tar coke. Fig. 3 shows the relative rates and degrees of carburisation obtained with these cokes. Results obtained in the small and in the large furnace are shown. These curves illustrate the detrimental effect of ash, and show that the absorption of carbon decreases as the ash content of the carburiser increases. The ash being a component part of the structure of the coke probably acts as a protective coating on the carbon, serving to keep it from intimate contact with the metal, this effect being intensified as the carbon dissolves and the relative amount of ash becomes larger. Graphite resistor carbon, coal-tar coke, petroleum coke, and charcoal should be desirable carburisers because of their low ash content. Of these, the denser varieties should be preferred.

Silicon Carbide.—Experiments with carborundum firesand (an impure silicon carbide) proved it to be an efficient means of introducing both silicon and carbon into iron. Inasmuch as the proportion of silicon to carbon in silicon carbide is roughly 2 to 1, it cannot be used for introducing all of the required carbon because too much silicon would result. It would also be too expensive for this purpose. However, its cost for introducing silicon would almost equal that of ferro-silicon and it would have the added advantage of effecting some carburisation. Fig. 4 shows the result of a test in which a high-ash coke and silicon carbide were used in conjunction. The scrap-steel plate was melted with a cover of the coke and held molten for an hour. Previous experience had shown that after an hour there would be practically no further absorption of carbon from this coke. At

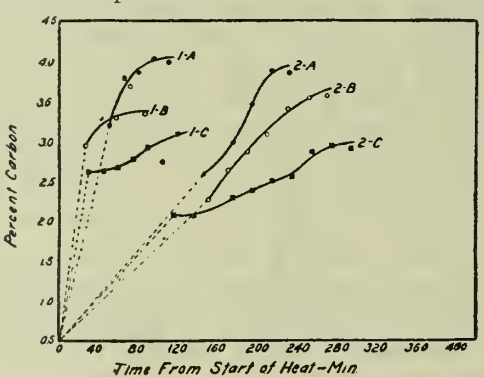


Fig. 3.

Showing the effect of ash content of carburisers on the rates of carbon absorption. Curves No. 1 from tests in 50 lb. pit furnace. Curves No. 2 from tests in 300 lb. roofed furnace.
A=Coal-tar coke (ash content, under 4 per cent.).
B=Low-ash coke (ash content, 12 per cent.).
C=High-ash coke (ash content, 25 per cent.).

this point, indicated by the arrow on the curve, carborundum firesand was thrown on the melt, with the result that the absorption of carbon continued rapidly until 3.9 per cent. carbon had been reached. Carbon and silicon were taken up by the iron in the ratio of 0.8 carbon to 1.55 silicon, which is very close to the proportion of carbon to silicon in silicon carbide. Assuming that the carborundum firesand contains 75 per cent. silicon carbide, the recovery in the iron of this silicon carbide as silicon and carbon was 75 per cent.

In most cases it will be noticed that the last point in the curve is slightly lower than the preceding point. The last point is taken from the analysis of the pig sample, and the other points are taken from the analysis of the samples obtained in the graphite mould. Due to the slow rate of cooling of the pigs, those which contained large amounts of silicon or carbon ejected graphite as "kish" and hence contained less carbon than their equivalent samples which were cast in small moulds, and therefore cooled too rapidly to permit the formation of so much graphite. The difference ordinarily amounts to about 0.1 per cent. carbon

Effect of Slags.

In general all of the tests have shown that slags interfere with carburisation. This interference is due to the physical effect of the slag in preventing contact between the carburising material and the metal. Therefore, in the tests unless the effect of the slag was being particularly considered, the surface of the metal was kept as free from slag as possible. The effect of high-ash coke has already been discussed (see Fig. 3). The ash from this coke consists essentially of alumina and silica. Curve F, Fig. 5, shows the effect of a high silica-alumina slag upon carburisation with low-ash coke (coal-tar coke). This slag was accidentally introduced by the fusing of part of the furnace lining. Results of other tests have indicated the retarding effect of siliceous slags upon carburisation.

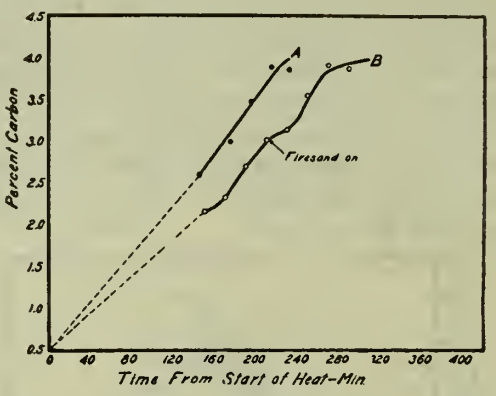


Fig. 4.

Showing the relative rates of carbon absorption when using coal-tar residue and carborundum firesand.
A=Coal-tar as carburiser. B=High-ash coke in first stage; firesand introduced as noted.

High lime-slags have practically the same effect due to the physical action tending to prevent contact. However, if conditions are right for the formation of calcium carbide, lime may aid carburisation. Curve B, Fig. 5, shows the results of tests with low-ash coke and a lime slag. Calcium carbide was formed by the arc, thus causing rapid introduction of carbon into the iron. In another test using calcium carbide and carbon, carburisation was still more rapid. Curve C is taken from an experiment in which calcium carbide alone was used as the carburiser. The carbon content of the iron increased rapidly and then stopped. Only 50 per cent. efficiency of the carbon in the carbide was obtained, showing that either a large excess of carbide must be used, or that carbon must be charged along with the calcium carbide. Curves E and H, Fig. 5, show the effect of lime on a high-ash coke. Carburisation proceeded fairly rapidly at first, but practically stopped until the first slag, which had by now largely increased in silica and alumina from the ash, was replaced by a fresh lime-slag.

Effect of Impurities.

In studying the effects of the common impurities in cast iron, it has been found that innumerable combinations and concentrations from them are possible. In these experiments the effect of silicon

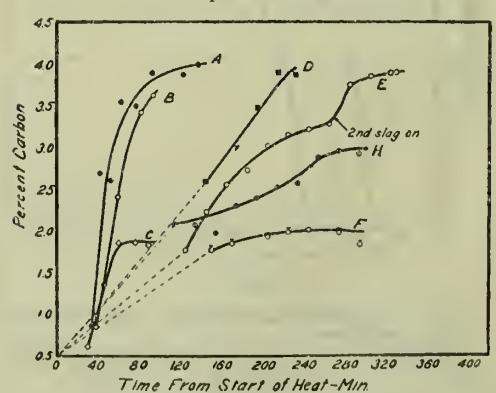


Fig. 5.

Showing the rates of carburisation with and without slag.
The curves denote.—Run in small furnace, using: A, charcoal alone; B, coke and a lime-fluorspar slag; C, calcium carbide and a fluorspar slag. Run in large furnace, using: D, coal-tar coke alone; E, high-ash coke and a lime-fluorspar slag; F, coke and silica-alumina slag; H, high-ash coke alone.

in the absence of other added impurities was first studied. Then the effects of sulphur, phosphorus, and manganese in the presence of about 2.0 per cent. silicon were investigated. Enough of the impurity was introduced to indicate its effect, but not enough to get too far away from concentra-

tions that might be met in practice, although in a few instances an unusually large amount was used in order to intensify the effect.

Silicon.—Although there is reason to suspect that silicon decreases the content of combined carbon in iron, in these tests it was repeatedly found to have practically no effect. The rates of carburisation were about the same for steel containing 0.2, 2.0,

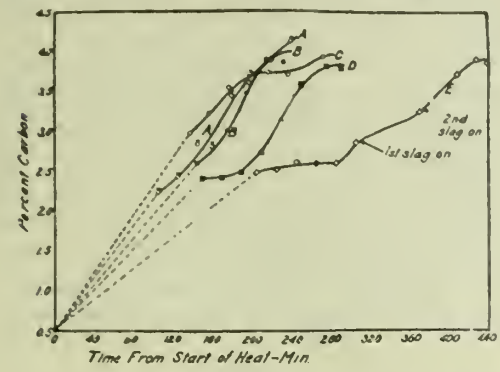


Fig. 6.

Showing effects of impurities on the rate of carbon absorption. Two per cent. silicon in all except curve C. Manganese, phosphorus and sulphur are low except as indicated below.

Percentages for the curves are as follows: A, 1.75 manganese; B, 2.00 silicon (other impurities low); C, 0.2 Si, 0.4 Mn, 0.5 S. & P.; D, 0.7 phosphorus; E, 0.75 sulphur.

and 7 per cent. silicon. Curves B and C in Fig. 6 show the rates of carburisation of steel containing 2.0 and 0.2 per cent. silicon respectively. The curve for 7 per cent. silicon is not shown here, but its slope is very much the same as the slopes of curves B and C. Thus it is seen that in these tests the content of silicon had no effect upon the rate of absorption of carbon by molten iron.

The curve in Fig. 7 shows the relation between the carbon and silicon contained in the metal obtained in the three runs made for the purpose of comparing the effect of silicon. The points on the curve represent the analyses of samples that were taken a few minutes before the charge was tapped. The samples were chilled so quickly that no graphite was ejected during cooling. These values, therefore, represent the carbon contained in the liquid iron and not in the cold pig. The curve was drawn to pass above the point corresponding to 7 per cent. silicon, because complete saturation of the iron had not taken place when the sample was taken. There is practically no difference between the carbon content of the chilled samples and that of the slowly cooled pig samples in the results for the 0.2 and 2.0 per cent. silicon runs, but there is a difference of 0.46 per cent. in the case of the 7 per cent. silicon run. These

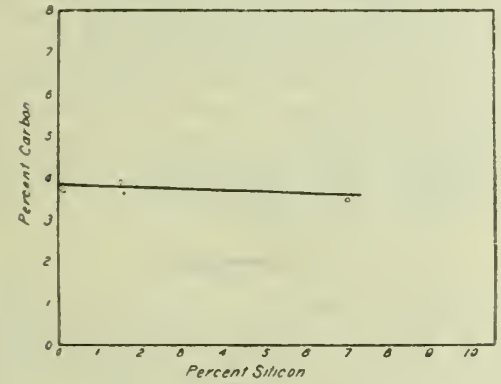


Fig. 7.

Showing the amount of carbon dissolved by iron containing various amounts of silicon, other conditions being similar. Points do not indicate saturation values.

observations show that although the presence of a large quantity of silicon does decrease the amount of carbon in the pig, it does not affect the amount of carbon that is absorbed by molten iron.

Manganese.—Curves A and C in Fig. 6 show the rates of carburisation for high manganese and low manganese irons respectively. By low manganese is meant 0.40 per cent., and by high manganese, 1.75 per cent. Curve A has a steeper slope than Curve B, indicating that manganese is beneficial. These curves are plotted from results obtained in the small furnace, but not indicated in this discussion. Although the results show a distinct effect, it may not be large enough to warrant the statement that manganese is beneficial. However, it is to be expected that manganese aids the carburisation of iron. Experiments are now being conducted to bring out further data upon this point.

Sulphur.—It is not to be expected that sulphur would materially affect the absorption of carbon by iron. However, during this investigation, the effect of sulphur has been strikingly noticeable. Sulphur has always appeared to retard the rate of carburisation and decrease the total absorption of carbon. Curve E in Fig. 6 and the curves in Fig. 8 are plotted from results obtained in a test in the large furnace, in which 0.8 per cent. sulphur was introduced during the melting period. Fig. 8 shows that the absorption of carbon had practically ceased when the first desulphurising slag was added, after which it increased regularly as desulphurisation continued. The effect of sulphur on the rate of carburisation is shown in Fig. 6. From an examination of the results obtained in several other tests, not described here, the deleterious effect of sulphur is evidenced when the sulphur content is as low as 0.1 to 0.2 per cent., although the effect is not so marked as in the example discussed above.

It is surprising that sulphur should have such a marked effect, and it is not improbable that further work may show that something other than sulphur is responsible. However, the results of

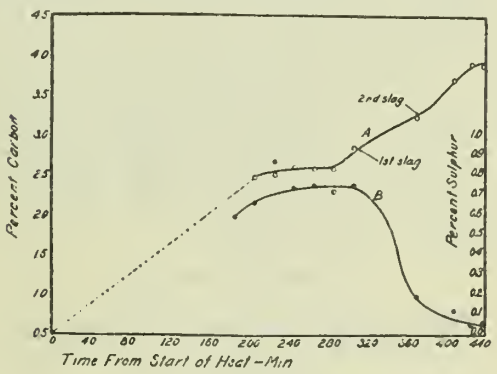


Fig. 8.

Showing the relation between carbon absorption and sulphur content. Sulphur was eliminated and carbon introduced toward the end of the heat by two successive carbon-lime-fluorspar slags.
A=Carbon curve. B=Sulphur curve.

the present study show very plainly that in the tests here described sulphur retards the carburisation of molten iron.

Phosphorus.—The study of the effect of phosphorus shows that it probably does not influence carburisation. Curve D, Fig. 6, showing the results of the high phosphorus (0.75 per cent. P) run, has an average slope of approximately the same degree as have the curves for the phosphorus-free runs. The slow rate of carburisation at the beginning of this test was undoubtedly due to the presence of some slag, because when this slag was removed absorption of carbon took place rapidly. In other tests performed in the small furnace, phosphorus showed practically no effect upon the rate of carburisation.

Conclusions.

1. The results indicate that the carburising ability of different forms of carbon decreases as the ash content increases, and that the denser varieties of carbon are more effective than the more porous ones. Artificial graphite, resistor carbon, petroleum coke, and coal-tar coke give better results than the higher ash cokes or charcoal. Although the low ash content of charcoal would put it in the class with graphite, its porous nature prevents good contact with the metal. Graphite, because of its lower ash and higher density, has given slightly better results than any of the other forms of carbon used.

2. The presence of slag decreases the rate of carburisation by tending to prevent contact between the metal and the carburiser. This action is more pronounced as the acidity of the slag increases.

Lime-slags counteract the deleterious effect of the high ash in coke, and, if conditions are right for the formation of calcium carbide, aid carburisation.

3. Silicon carbide is an excellent medium for adding both silicon and carbon to iron. It cannot be used for introducing all the carbon because too much silicon would be carried into the metal and also the cost would be too high. Silicon carbide should be used in the comparatively inexpensive form of firesand and in conjunction with one of the low-priced carburisers, such as coke.

4. Silicon has no effect upon the rate or the degree of carburisation, although it may slightly decrease the content of total carbon in the resultant pig.

5. Manganese seems to increase both the rate and the degree of carburisation, although this increase is so small as to be negligible for the amounts of manganese ordinarily met with in commercial iron.

6. Phosphorus has no effect upon the rate or the degree of carburisation, although, like silicon, if present in large quantities, it may decrease the content of the total carbon in the pig.

7. Sulphur probably decreases the rate and the degree of carburisation. No attempt has been made to explain this unexpected action.

8. An increase in temperature from 1,350 to 1,450 deg. C. has no noticeable effect upon the carburisation.

Acknowledgments.

Much credit is due Mr. B. M. Larsen, "fellow" in electrometallurgy, University of Washington, and Mr. A. E. Anderson, junior metallurgical chemist, U.S. Bureau of Mines, for assistance with the experimental and analytical work. Grateful acknowledgment is made to the College of Mines of the University of Washington for the use of its laboratory facilities, and to members of its faculty for helpful co-operation. The authors also wish to express their appreciation for the helpful encouragement and criticism received from Messrs. D. A. Lyon and O. C. Ralston of the U.S. Bureau of Mines.

Obviating Contraction Strains.

By F. C. Edwards.

If it is true that engineering design consists of one part calculation and five parts judgment, we may quite safely assert, *à fortiori*, that in the equation of good casting design, judgment and calculation may be represented respectively as ten to one. That this is by no means an unfair balance of values will, perhaps, be readily conceded when it is remembered that the convenient and much-abused "factor of safety"—generally dependable in the case, say, of mild-steel structures—if applied solely on the basis of more metal, more strength, may produce, in castings, diametrically opposite results to those intended.

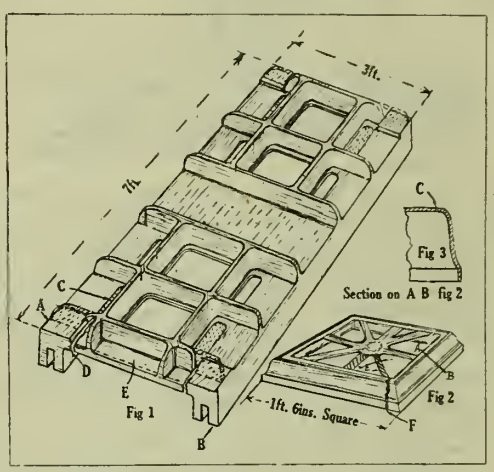
In this sphere, by the way, the wielder of mathematical formulæ is no match for the practical foundryman. The latter's judgment is almost invariably vindicated. It is, nevertheless, frequently undervalued. With regard to contraction strains, in particular, foundry opinion is of infinite value to the designer. It should never be slighted—as is, unfortunately, sometimes the case. It deserves, indeed, to be assiduously courted.

Readers of this journal will probably call to mind cases where patterns have been sent to the foundry, perfect, perhaps, in the eye of the designer, but in which—almost at a glance—fatal sources of weakness have been detected by the foundry chief. By a kind of intuitive perception—the fruit, so to speak, of daily observation and experience—he unerringly indicates, say, the probable line of fracture, and suggests an effective remedy. This, of course, may involve sacrifice in design or expense in subsequent machining. On such a point, however, there is really no room for argument. Though one's pet design be somewhat mutilated, or machining cost be slightly increased, these are obviously lesser evils to face than the probability of a scrap casting, or the likelihood of contraction strains being present in an apparently sound casting. Occasionally, of course, the risk is taken. If the casting flies in cooling, the foundry judgment is vindicated; and it is not necessarily disproved if the casting remains intact.

A striking example of the former case is illustrated in Fig. 1. As will be gathered from the sketch, the pattern was well ribbed, and it was considered to be generally sound in design. On its arrival in the foundry, however, its weak spots were soon detected. On account of the presence of machined facings, A, at the extreme corners, the end transverse ribs were not carried right across, as in the case of the other ribs. To the trained eye it was evident that this shortening of the ribs, taken in conjunction with the comparatively heavy longitudinal bars, B, and the lightening holes, C, constituted a real source of weakness. For various reasons, however, it was decided to make no change in the design.

Exactly as predicted, and in spite of the fact that the side bars were quickly exposed, after casting, to assist equalisation of cooling, the casting gave way at D, but at one end only.

The foundry manager's advice was then acted upon. Holes, C, were filled up, and the ends, E, were made ¼in. thicker. In addition, the ribs were



continued to the outside, as shown in dotted section, to be afterwards machined off. The result was perfectly satisfactory; and no further trouble was experienced with subsequent castings.

Figure 2 is another illustration of the effect of, and remedy for, contracting strains. As is shown in Fig. 3, the metal is only ⅛in. in thickness, and there is an internal lip, C, round the top edge. The gates, at their junction with the castings, must be almost knife-edged to avoid breaking pieces out of the frame when they are knocked out. Hence the large number of gates employed—more, perhaps, than some moulders would consider necessary. In addition, of course, they serve as an insurance against the possibility of "cold" metal.

Almost immediately after casting, the two sectioned gates, E, are broken out. This is done to relieve the contraction strain. If this precaution is neglected, the frame invariably flies across one of the corners, as at F.

Enough has been said, perhaps, to show that contraction strains—baneful though they be—can be obviated, but practical experience alone can best furnish the solution.

The Basset Process.—The report of the Société des Aciéries Basset states that while the chemistry of their steel-making process had entirely fulfilled the claims of the inventor, questions as to the form of the furnaces and their linings had presented great difficulties, mainly on account of the exceptionally high temperature prevailing in the furnace. This temperature made possible the obtaining of a product free from injurious impurities, and although it was technically possible to reduce it, the firm did not desire to discard the advantages which it afforded, and consequently attention had been concentrated on the improvement of the refractory properties of the lining. Efforts in this direction had met with a measure of success, and the progress achieved gave the firm confidence that a satisfactory result would shortly be reached. During 1921 the Company had studied the most rational form of furnace corresponding to the various qualities of pig-iron used and steel obtained. Although actual commercial activity had not yet commenced, initial deliveries of metal had been made.

The Development and Manufacture of High-Tenacity Brass and Bronze.*

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from page* 80.)

Tin Brass.

The chief function of tin in brass is to improve the corrosion-resisting properties. In complex brasses of high ductility 0.7 per cent. is the maximum amount that should be used. In naval brass the limit is 1 per cent.

In a series of exploratory casts it was found that the amount of tin that brass will take into solution in the solid state is determined by the Zn. content. In the "alpha" series, the lower the Zn. content the greater the quantity of Sn. which it can dissolve, e.g., an 80/20 brass will dissolve 5.0 per cent., whilst a 70/30 will scarcely dissolve 1.0 per cent. Of the "alpha-beta" series, the standard 59/41 brass dissolves approximately 1.0 per cent. when sand-cast and 1.2 per cent. chill cast, whilst as the Zn. content increases up to 47 per cent. the solubility rises to a maximum of 1.80 per cent. From these results 0.5, 1.0, 2.0 and 3.0 per cent. tin brasses were made of a 59 per cent. copper base. Conditions of manufacture were those outlined for the aluminium brasses, introducing the Zn. and the Sn. as such, last.

Physical Test Results.—These are detailed in Table IV.

Structure.—There is little perceptible difference in the structure of an "alpha-beta" brass containing 0.5 per cent. Sn. and that containing 1 per cent. Exceeding 1 per cent. a brittle Cu.-Sn. compound, resembling the Cu.-Sn. compound, found in ordinary Sn. bronzes, makes its appearance. The effect of this constituent is shown to be similar to the "gamma" compound in ordinary brass.

From these results one cannot regard Sn. in the same light as any of the elements previously considered, it being neither a Cu.- nor a Zn.-replacing element; although, structurally, attempts have been made to consider it as a Zn.-replacing element, giving to it a co-efficient of equivalence of 2.

Iron Brass.

Copper and iron form a heterogeneous series of alloys except at the terminals of the curves. Between these proportions the alloys consist of two constituents, the one rich in iron the other rich in copper. Carbon and copper do not associate in any form, and the presence of C. in Fe. reduces the solubility to any extent that neither steel nor cast iron can be satisfactorily alloyed with copper, but merely exist side by side as a mechanical mixture of one with the other. Zinc readily unites with iron.

Iron may be introduced into brass by means of a Cu.-Fe. or Zn.-Fe. stock alloy. The preparation of either stock alloys is a comparatively simple operation, if certain elementary chemical laws are observed and manufacture carefully conducted. The first essential in the preparation of a Cu.-Fe. stock alloy is the use of pure iron, not steel, cast iron or ferro-manganese. The iron may be purchased in sheet form as scrap clippings from horse-shoe nails or as Swedish bar-iron. The Cu. should be melted to a good temperature under a suitable slag, and the iron introduced in small quantities at a time up to about 10 per cent. and well stirred. When thoroughly alloyed, the pot should be withdrawn from the furnace, again stirred and quickly poured out into a thin flat mould. Unless this latter precaution is taken, there is a danger of the iron rich material formed segregating in the upper regions of the cast.

Correctly made, a 10 per cent. Fe., Cu.-Fe. stock-alloy is soft, and has a Brinell hardness of 62 against 55 for pure copper and 92 for pure iron.

Johnson recommends the use of a Zn.-Fe. stock-alloy, prepared by immersing strips of clean sheet-iron in a crucible of molten Zn., the temperature of which is maintained for several hours at 800 deg. C., in a muffle furnace. Luting on the

TABLE IV.—*Showing the Effect of Tin on the Physical Properties of Brass.*

Series No.	Composition. Cu.	Zn.	Sn.	Fe.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. per cent. on 2 in.	R. A per cent.
S.1	59.95	39.38	0.47	0.20	As cast	11.0	26.2	44.0	42.0
					As forged	15.6	28.8	38.0	60.0
S.2	58.90	40.10	1.00	Trace.	As cast	9.6	26.7	32.0	33.5
					As forged	13.6	28.6	38.0	44.6
S.3	58.82	38.76	2.11	0.31	As cast	11.8	26.1	13.0	15.0
S.4	59.17	37.63	2.98	0.22	As cast	16.4	21.25	1.5	3.2

TABLE IV.—continued.

Series No.	Tensile Fracture.	Alternating impact No	Fracture.	Brinell hardness No.	Sclerescope hardness No.
S.1	Fine, stony, silky edges. More or less hackly ..	77	Fine, silky, semi-vitreous	87	13
	Fine, granular, silky edges. Cup and cone ..	113	Fine, granular, semi-vitreous in upper half.	107	15
S.2	Fine, stony, silky edges. Trace of crystallinity existing as exhibited by S.3.	47	Fine, crystalline, with a slight appearance of the laminated crystals exhibited by S.3.	98	15
	Fine, granular, silky edges. Semi-cup and cone ..	107	Fine, granular, semi-vitreous in upper half.	107	16
S.3	Short, coarsely crystalline, consisting of greyish and stony crystals existing alternately	5	Short, grossly coarse laminated crystals.	114	20
S.4	Coarse, alternating grey and stony coloured crystals.	1	Short, coarse, laminated crystals ..	136	23

As Cast.—0.50 per cent. Sn. increases the yield point and maximum stress 2.25 tons and 1.3 tons respectively without affecting the elongation, reduction of area, and alternating impact strength. Increasing to 1.0 per cent. hardens, without strengthening, and impairs both the ductility and impact strength. This embrittlement is naturally accentuated by further quantities of Sn., as in alloys S3 and S4, the latter having little strength and being void of ductility.

Forging.—No difficulties were encountered in the forging of alloys S1 and S2, and worked with the ease of ordinary Muntz metal. The test results of alloys S3 and S4 in the "cast" condition were such that they did not justify consideration in the forged or heat treated condition.

After forging the yield point of S1 is raised 6.6 tons per sq. in., and the maximum stress 2.8 tons per sq. in., but the elongation is slightly reduced. The drop in ductility, however, is not of material importance, the alternating impact figure being raised no less than 15 per cent. Whilst the physical properties of the 1 per cent. Sn.-brass in the "cast" state are inferior to those of 59/41, they are superior after forging, but it is clearly demonstrated that 1 per cent. is the limit of practical utility.

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

crucible lid is suggested for preventing volatilisation.

This method is costly on account of the difficulties of manufacture; moreover, one cannot dissolve, commercially, more than 6 per cent. Fe.; consequently its use cannot be adopted for high-Fe. iron brass of low-Zn. content. Commercial Zn.-Fe. stock-alloys are generally prepared by liquidating the hard Zn. from galvanising works to remove part of the Zn., and then heating the Fe.-rich residue to a high temperature until the desired Fe. content is obtained. The objection to this by-product is its irregular composition and the impurities it carries.

Effect of Iron on 70/30 Brass.

To ascertain the effect of iron on 70/30 brass ("alpha") three alloys were made and designated F, F1, and F2. The first contained 70 per cent. Cu. and 30 per cent. Zn.; the second 69.75 per cent. Cu., 29.75 per cent. Zn. and 0.5 per cent. Fe.; and the last 69.50 per cent. Cu., 29.50 per cent. Zn. and 1 per cent. iron.

The iron was introduced by the 10 per cent. Fe., Cu.-Fe. stock-alloy. No peculiarities or difficulties were encountered either in melting or pouring. The tensile, impact and hardness tests are tabulated in Table V.

In the cast condition 1 per cent. Fe. is shown to raise the yield point from 6.5 to 10.7 tons per sq. in., the tenacity from 16.7 to 24.5 tons sq. in., and the Brinell hardness from 55 to 76 without materially affecting the ductility as measured by both the static and dynamic stress tests. After cold-rolling and annealing, the yield point is raised from 8 to 11 tons per sq. in. and the tenacity from 21.5 to 26.5 tons per sq. in., also without affecting the ductility. The most interesting feature is the beneficial effect of iron on the physical properties in the cast state, whilst the range of physical properties possible from 70/30 brass containing 1 per cent. Fe. is noteworthy, as they give a yield point of 10.7 to 18.5 tons per sq. in., a maximum stress of 24.5 to 41 tons per sq. in., an elongation of 14 to 54 per cent., a reduction of area of 44 to 67 per cent., and a Brinell hardness of 76 to 185.

A series of experiments on the effects of Fe. on malleability—which property was determined by cold-rolling to destruction, cupping and drawing tests—proved that Fe. up to 1 per cent. is not detrimental if correctly alloyed, the intervening annealings correctly performed and the changed physical properties taken to account. Fuller details of these tests are published in the "Metal Industry," Vol. 17, No. 22, page 421.

Microstructure.—The beneficial influence of Fe. in the manufacture of brass castings is readily explained by means of the microscope.

The outstanding feature is the refining effect of small quantities of iron on the texture and the improved homogeneity. The explanation of the mechanism of its action is not far to seek. Iron exists in brass as an insoluble constituent rich in Fe. in the form of finely-divided particles, each of which acts or tends to act as a nucleus for the germination of a primary crystal-grain. The true solubility of Fe. in 70/30 brass is unknown. By ordinary microscopical examination the Fe.-rich particles are just discernible between 0.35 and 0.45 per cent. That the actual solubility is less than this figure is shown by the grain-refining of less quantities than 0.35 per cent. For ordinary workshop practice, however, 0.35 per cent. may be taken as the solubility limit, this being the safe-working limit of iron for articles which are to be spun, cupped or drawn.

Table V.—*Showing the Effect of Iron on the Physical Properties of 70/30 Brass.*

Mk.	Composition. Cu.	Zn.	Fe.	Treatment.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Alternating impact No.	Izod impact No.	Brinell hardness No.	Scleroscope hardness. No.
F.	69.80	30.20	Trace.	As cast	6.50	16.70	58.00	46.20	79	41	55	15
				Cold rolled and annealed, 650° C. ..	8.00	21.50	68.00	65.00	—	61	57	15
F.1	69.67	29.82	0.50	As cast	8.70	19.40	58.00	47.20	61	49	64	12
				Cold rolled and annealed, 775° C. ..	9.50	22.80	65.00	67.00	—	—	54	10
F.2	69.42	29.57	1.00	As cast	10.70	24.50	50.00	59.30	80	45	76	12
				Cold rolled and annealed, 700° C. ..	14.00	27.00	47.00	62.00	—	63	92	12
				Cold rolled and annealed, 825° C. ..	11.00	26.50	54.00	67.00	—	—	76	12

Effect of Iron on 59/41 Brass ("Alpha Beta.")

The composition of the materials used were similar to those adopted for the 70/30 series, except that the iron was introduced into alloy 1.F.2. by means of a Zn.-Fe. stock-alloy and that 2½-in. sq. ingots were cast instead of 1-in. slabs. The tests results are shown in Table VI.

In ingot form 1.0 per cent. Fe. improves both the tenacity and shock-resisting properties. No further improvement is to be gained by exceeding this quantity whilst the shock-resisting properties tend to fall; particularly is this so in the case of alloy 1.F.2. The low ductility of this alloy, however, is accounted for to some extent by the crystalline form of the impurities introduced by the Zn.-Fe. alloy, and is typical of the troubles encountered when this impure material is used for the purpose of introducing iron.

Hot-working results in an all-round improvement of the tenacity of each alloy, having little influence on the ductility, except in the case of alloy 1.F.2, which improvement is as expected.

Microstructure. — The Fe.-rich constituent appears to be similar in form to that found in the 70/30 brassos, although the limit of solubility seems to be increased. It exerts a similar action on the crystal growth.

Effect of Iron on 53.3/46.7 Brass ("Beta.")

In view of the fact that the hardness of pure iron is similar to that of 59/41 brass, its limitations as a hardener or strengthener will be in brasses containing up to 41 per cent. Zn., and that it will neither effect the tenacity nor hardness of "beta" brasses. Its common use in high

Table VI.—*Showing the Effect of Iron on Alpha-Beta Brass.*

Series No.	Composition. Cu.	Zn.	Fe.	Pb.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Fracture.	Alternating impact No.	Fracture.	Brinell hardness No.	Sclerescope hardness No.
1.F.	58.96	41.04	—	—	As cast ..	8.80	24.90	45.00	49.70	Fine, stony, semi-cup and cone.	79	Fine, granular, silky edges.	90	14
					As forged ..	9.00	26.00	47.50	62.00	Fine, stony, silky edges.	87	Fine, granular, silky edges.	90	14
1.F1.	59.37	39.68	0.95	Nil.	As cast ..	9.40	26.80	44.00	44.60	Fine, silky, semi-cup and cone.	95	Fine, silky, semi-vitreous.	90	13
					As forged ..	13.90	28.80	44.00	63.70	Fine, granular, cup and cone, silky edges.	81	Fine, stony, semi-vitreous.	107	14
1.F.2	59.04	38.95	1.56	0.45	As cast ..	11.00	26.80	33.00	30.60	Fine, stony, granular, semi-cup and cone.	31	Fine, stony ..	85	13
					As forged ..	13.60	27.60	43.00	59.30	Fine, granular, cup and cone, silky edges.	49	Fine, stony, inclined to be vitreous.	98	15
1.F.3	59.12	38.36	2.52	Nil.	As cast ..	10.00	26.50	46.00	49.70	Fine, silky, semi-cup and cone.	71	Fine, slightly more silky in appearance than 1.F1.	92	14
					As forged ..	15.80	28.30	39.00	54.60	Stony, granular, uneven.	79	Fine, stony, semi-vitreous.	110	16

tenacity brasses, therefore, must be a question of the manner in which it affects the crystal growth. To investigate this, three alloys were made, and designated 2F, 2F1, and 2F2. The first contained 53.3 per cent. Cu. and 46.7 per cent. Zn., the second 51.5 per cent. Cu., 47.5 per cent. Zn., and 1 per cent. Fe., whilst the last one was made up of 51 per cent. Cu., 47 per cent. Zn., and 2 per cent. Fe.

The copper and zinc were adjusted so as to bring each to a similar position in the "beta" phase area of the copper zinc constitutional diagram.

Materials used, conditions of manufacture, and method of casting were identical to those adopted in the 59/41 series, excepting that only the Cu.-Fe. stock-alloy was used for the purpose of introducing the iron.

Mechanical Properties.—Chemical composition and physical test results obtained are embodied in Table No. VII. These indicate Fe. to be detrimental to the ductility in the "cast" state, but beneficial when forged. It will be observed also that forging lowers the yield point but raises maximum stress, increases but the yield point and the maximum stress of alloy No. 2F1 and lowers both the yield point and maximum stress of alloy 2F2 though each was treated similarly and has the same Brinell hardness in both the "cast" and the "forged" condition.

TABLE VII.—*Showing the Effect of Iron on the Physical Properties of "Beta" Brass.*

Mark.	Composition. Cu.	Zn.	Fe.	Pb.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A Per cent.	Fracture.	Alternating impact No.	Brinell hardness No.	Sclero-scope hardness No.	No. of crysta grains per sq. cm.
2.F.	53.41	46.59	Nil.	Nil.	As cast ..	9.00	29.70	24.00	21.50	Coarse, crystalline, exhibiting brilliant lustre.	34	114	15	39
					As forged ..	8.70	32.80	28.00	30.60	Coarse, flaky, exhibiting brilliant yellow crystalline facets, extension uniform over the 2 in. parallel.	49	114	15	488
2.F.1	51.72	47.23	1.05	Nil.	As cast ..	8.00	30.90	16.00	15.00	Fine, crystalline, exhibiting brilliant crystal facets.	9	114	15	1,765
					As forged ..	9.60	33.00	38.00	33.50	Flaky, uneven ..	39	114	15	2,336
2.F.2	50.77	47.03	2.20	Nil.	As cast ..	11.10	33.00	17.00	15.00	Fine, crystalline, exhibiting brilliant crystal facets.	9	114	17	2,314
					As forged ..	8.60	30.60	43.00	44.60	Fine, yellow, almost granular.	85	114	17	2,200

Microstructure.—The mechanical properties of "β" brasses being unaffected by normal heat treatment—both tenacity and ductility being similar, no matter the rate of cooling—the changes responsible for the peculiar test results, which are typical of those obtained from complex "β" brasses, must be attributed to one or all of the following causes:—(1) Internal molecular changes or structural conversion of the "β" constituent; (2) geometrical outline of the crystal grains; (3) the mode of distribution of the free Fe.-rich constituent.

Actual examination proved that iron renders both the internal and external form of the crystal grains more regular, and that this is the principal cause of its embrittling properties in cast brass. Forging, refining and effecting an interpenetration of adjacent crystal grains explains the improved ductility wrought by mechanical work. The effect of the iron rich particles is unimportant, providing they are uniformly distributed and in a fine state of division.

Having established the functions of the third element in the development of High-tenacity brass, the effect of two or more elements in combination will now be considered.

(To be continued.)

Legal Position with Regard to American Steel Mergers.—The U.S. Attorney-General (Mr. H. M. Daugherty) has informed the Senate that in his opinion the proposed merger of the Bethlehem and Lackawanna Steel Companies and the Midvale, Republic and Inland Companies would not be a violation either of the Sherman Act, the Clayton Act, or the Webb Act. He declined, however, to express an opinion whether such consolidations would constitute a violation of the Federal Trade Act.

Manganese in India.

Writing on this subject in the "Engineering and Mining Journal-Press," Mr. E. W. T. SLATER remarks that before the war the greater part of the world's supply of manganese ore came from Russia and India, but in the last few years there has been discovered other sources in Brazil, on the Gold Coast of Africa, and in a few other places. Nevertheless, in spite of the competition of the new fields there is little doubt the manganese industry in the first two countries will continue to develop as the demand increases. The Indian fields have proved most useful, and the reports all go to show that the prospects for the future are good. The Indian ore, on account of its hard, lumpy form, is much more suitable for blast furnaces than the more friable ores obtained from the Caucasus; and it is also possible, owing to the better selection, to export a product of more uniform quality than that which characterises the Russian shipments.

The ores from the central provinces are considered to be of the highest grade, while those from Vizagapatam and Mysore belong mainly to the second and third grades. The ores of the first grade have a high manganese content, usually from 49 to 54 per cent. and a moderately high iron—from 4 to 8 per cent. The silica varies from 6 to 9 per cent. and the phosphorus from 0.07 to 0.14 per cent. The second and third grades are characterised by high iron and phosphorus contents and comparatively low silica. Though a good deal of prospecting has been done, there have been no new fields of considerable size discovered in other parts of India, though it is yet too early to say what a more complete survey will reveal. At present practically all the ore mined in India is shipped to Europe and America for conversion; only a few thousand tons are used in India, and this chiefly as a desulphuriser in iron and steel furnaces. With increased development of the iron and steel industry in India, doubtless a larger demand will be made on the supplies, but for many years to come India necessarily will seek a market in the West. Unfortunately the high percentage of phosphorus in Indian iron ore and coke makes the supply not so satisfactory for Indian use as supplies from other parts. But with the improvements in the iron industry, the necessary adjustments will probably be made.

Some years ago the manufacture of ferro-manganese was begun in India in the works at Jamshedpur, and the alloy produced was of the following composition: Manganese 70 per cent., phosphorus 0.55 per cent, and silicon 2 to 3 per cent. The output from one furnace reaches about 80 tons a day. Ferro-manganese is also manufactured by the Bengal Iron & Steel Company, the product having a guaranteed maximum of 74 per cent. manganese and a maximum of 0.55 per cent. phosphorus. It is believed that, with a careful selection of the Indian ores, some real advance may be shown, though, as has been pointed out, new methods will need to be adopted in the blast furnace if India is ever to become eminent as a maker of ferro-manganese. The possibilities of utilising electric energy will have to be carefully considered.

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.*

By Enrique Touceda (Albany, New York).

(*Continued from page 77.*)

Metallurgy of Melting.

All of the author's correspondents and visitors appeared to be very familiar with the reactions that take place in the air furnace. Covering the ground very briefly, it can be stated that the carbon is eliminated mainly as CO. Neither the sulphur, nor the phosphorus, are permanently oxidised, while there will be an increase in the former that may amount to little or much, depending upon the amount of sulphur in the fuel. The silicon and manganese are in part oxidised to silica and manganous oxide respectively, while, unavoidably, some of the iron is being oxidised at the same time, with the result that double silicate of iron and manganese is formed, which if the liming and bottom were inert and no dirt or sand accompanied the charge would constitute the slag. As there is more or less erosion of both sides, walls and bottom, and invariably some foreign siliceous matter introduced with the charge, the slag consists of mixed silicates of iron, manganese, alumina, lime, magnesia, soda, potash, etc., in which the silicates of iron will predominate. In a normal heat the elimination of that part of the silicon, manganese and carbon which is lost, takes place mostly while the charge is melting, and in the absence of very small or thin scrap, will amount to about 28 per cent. of the silicon, from 15 to 19 per cent. of the carbon, and from 40 to 50 per cent. of the manganese, all based upon their original content in the mixture. If it is expedient to use small thin scrap, owing to its lower cost or because it is a by-product of the plant, it should be charged in the molten bath in order that it will be protected from excessive oxidation. While the composition, to which reference has been made, is the one recommended for general use, it is not to be understood that quite wide departure cannot be taken in the case of most of the elements. Some ten years ago attention was rarely, if ever, paid to the carbon content in the product, principally because its importance was not recognised. Inasmuch as the carbon content in pig-iron must have averaged at least as high as 3.35 per cent., and, inasmuch as the sprue must under these conditions have been exceedingly high in this element, it was imperative to run on a low-silicon mixture in order to secure a silicon-carbon ratio that would yield white iron in sections of even medium thicknesses. While to-day it is in no sense unusual to run both thin and heavy castings from the same furnace, at the time referred to this was not considered practical. As a general proposition little thought was given to manganese, which was frequently too low or too high, with the result that many heats of low-silicon, accompanied by low manganese, resulted in the production of a "picture-frame" product, by which is meant a finished product that shows upon fracture an outer surface ring or frame ranging in thickness from 1-64 in. to 1-16 in., or even deeper in exaggerated cases; wholly different in appearance from the metal which it surrounds and separated from it by a sharp line of demarcation. As a matter of fact, this character of fracture, whether resulting from this or other frame-producing mixtures, was so general that the name black-heart malleable iron was given to the finished product, and there is ample evidence to show that it was the aim to obtain this character of fracture.

The author's reason for placing the silicon at 0.90 per cent. and the carbon at 2.35 per cent. is because these figures call for a silicon-content of about 1.25 per cent. and a carbon-content of about 2.70 per cent. in the mixture—limits sufficiently high, on the one hand, to produce a product whose mechanical properties still will be excellent, even if the oxidation of these two elements exceeds their average elimination by a substantial margin; while on the other hand, in the event that the elimination is somewhat less than the average, neither are so high that the product will suffer deterioration in consequence. The fact must not be lost sight of that the percentage of silicon, carbon, and manganese recommended for the mixture is at a point at which, if the furnace is worked normally, the metal will be hot enough to pour by the time the molten bath has arrived at the hard-iron composition decided upon. As has already been indicated, not only is the best design of air-furnace a rather crude affair, but it is not operated by metallurgists. In Fig. 3 is outlined a 20-ton air-furnace designed by the author, that seems to have given satisfaction. Consequently, for commercial reasons, it is well to aim for that composition which safely will admit successfully of reasonably wide variation. With a sulphur content of 0.06 per cent., and other elements balanced, it makes but little, if any, difference at all in either the tensile or shock test, whether the manganese is as low as 0.22 per cent. or as high as 0.30 per cent. While further reference to manganese will be made, the author would point out that, as far as he is aware, there are still some things to learn about this element and the manner in which it is capable of existing. It is a generally accepted fact that, if the manganese is in excess of the amount necessary to unite in theoretical proportion with sulphur to form manganese sulphide, the excess will unite with carbon, and a manganiferous-cementite will be formed instead of the single carbide of iron. However, when graphitisation takes place and is completed, in what form does this excess manganese remain in the finished product?

Phosphorus in Malleable Iron.

Concerning phosphorus, the limit has been placed at 0.20 per cent., because, when in this amount, it does not appear to produce an abnormal appearance of fracture, even in the case of thick sections, at annealing temperatures around 900 deg. C., nor does it appear to lessen strength or ductility. It happens, however, that the limits for the impurities are so interdependent that, for economic reasons, prudence calls for what might be termed a metallurgical safety-factor in the balancing of the different elements. For thin-sections like stove-plate it is well to work on a phosphorus-content of about 0.26 per cent., due to the increased fluidity resulting therefrom, coupled with the fact that the fracture is in no way undesirable.

Slag Conditions.

Leaving this matter as it stands, for the present, there are some hints that may prove of value in connection with the operation of the furnace. The author has already pointed out that the coal-bed should be left undisturbed except to level the bed. He would make the same recommendation in connection with the molten bath of metal, except the necessary disturbance that takes place in hooking into the bath partly exposed pig or sprue, to expedite fusion during the melting-down period; while removal of the slag should be postponed as late as is practical. If machine-cast pig can be purchased as cheaply as the sand-cast, this should be used in preference; while it will be found, if the sprue is partially broken up by means of a light-weight sledge, that, owing to its brittleness, not only can this be done quickly and cheaply, but through this practice much of the adhering sand will be knocked off that otherwise would find its way into the hearth, with the further advantage that the sprue can be charged much more compactly. Every effort should be exercised to prevent foreign

* This Paper was the American Foundrymen's Exchange Paper, and was read before the Birmingham Conference of the Institution of British Foundrymen.

siliceous material from entering the hearth, when this can be accomplished at such little cost. In a test on twelve heats, amounting to a total of 192.8 tons, the slag from these heats, weighed on the same scale, amounted to a total of 12.7 tons, or 6.62 per cent. From this slag there was recovered 5,140 lbs. of metallic iron. At this plant no special precautions had been taken to prevent foreign siliceous matter entering the hearth. It will be found, if such precautions are taken, that a very substantial benefit can be affected by the end of the year through a saving in fuel, in better furnace-control, less slag to wash, and free from iron, etc. If, due to lack of business, it is essential to run the air-furnace at considerably less than capacity, the hearth should be shortened by filling-in with bottom-sand at the rear-bridge, for such a distance as will leave the bath, when molten, almost as deep as when the furnace is being run at capacity; otherwise, due to a shallow bath, the elements will be oxidised to a greater extent than under normal operations.

In determining the space between rear-bridge and roof, to regulate flame-travel, it is advisable at the start to build the top of the bridge slightly too low, securing the final adjustment by bricking-in at each end between bridge and roof, through which procedure the correct area, more quickly and conveniently, can be ascertained, after a trial or two, than through adding or removing a course of brick from the top of the bridge.

Sampling.

In following the progress of the heat it is the general practice to cast what are called test sprues at intervals of about half an hour after the charge has melted. These are broken and the fracture examined, in order to ascertain the rate at which graphitisation is diminishing. In the cooling of these test sprues the practice varies, and it is possible that the fracture, far from enabling one to approximate closely the correct story, can be very misleading. Two precautions must be taken. First, the centre section at about where the sprue should be broken should not be less than about $1\frac{3}{4}$ in. dia., and the cooling should not occupy less than about 20 mins. As soon as the sprue has solidified it should be removed from the sand, which should be scraped from the surface. It should be cooled in the air for 10 mins., and then quickly plunged in water and almost instantly removed, this procedure being repeated about every half-minute, allowing the sprue to remain in the water for a slightly longer interval at each dip, and this continued until when again dipped it ceases to create any visible agitation. At this temperature, if broken, it will have the same appearance as if it had not been fractured until actually at atmospheric temperature. If instead of one sprue two are poured at the same time, one being allowed to cool normally in the mould, in order that its fracture can be subsequently compared with the sprue that was cooled in the regular manner for test purposes, it will not be long before an observer can closely estimate and allow for the effect produced by the drastic cooling. If the cooling of the test-sprue be carried out in this manner it can be stated that for castings with sections as thick as $\frac{7}{8}$ in. no danger need be anticipated, that primary graphite will be present if in the sprue last taken the fracture shows clear, except for the presence of a few minute specks of graphite very sparsely disseminated throughout.

At this point a few words in connection with the castings as cast may prove pertinent. If owing to the use of a poor consignment of fuel, to neglect or bad judgment on the part of the furnacemen, a heat is delayed and an undue amount of silicon, manganese, and carbon eliminated, this can be detected by the sudden stickiness and sluggishness shown by the metal as it is being poured from the test-ladle, also by the appearance of pin-holes at different places on the periphery of the very thin rim of the test sprue. While castings from such a heat would, when annealed, have a picture-frame or an all-steely fracture, dependent upon how badly oxidised the metal, the heat can be saved if promptly treated by a silico-spiegel addition, or an addition consisting of a combination of ferro-silicon, ferro-manganese, retort-coke, and iron-borings bonded in briquette form, the borings being added to give increased weight to the mass in order that it will sink into the molten bath as far as possible. It can be stated that, through close observation, almost any over-oxidised heat may be saved in this manner.

But whether the castings are derived from a heat of the composition recommended, from a heat from which a greater amount of the oxidisable elements have been eliminated than in the case of the former, or from one in which the carbon particularly borders on the higher limit, there are certain practices concerning which the author would hesitate to make mention were it not for the serious losses sometimes occasioned through neglect to observe precautions of so obvious and commonplace a nature. At times complaints have been received concerning the heavy losses resulting from the checking and cracking of castings. With the knowledge possessed by the foundrymen that the lower the carbon the less fluid, and the higher the contraction of the molten air-furnace iron, he is prone to attribute such losses when extraordinarily heavy, wholly to the fact that in the effort to obtain high-tensile and ductile metal, the fluidity and contraction of the iron have been adversely affected through the use of a low-carbon composition.

In his examination of some of these complaints, the author has found conditions, entirely apart from composition, that have actually invited this character of trouble. Owing mostly to failure on the part of the engineer-designer to co-operate with the foundry engineers, the foundry is called upon to make castings from patterns of intricate design and of unreasonably disproportionate sections and not infrequently from poor pattern equipment.

Hard-iron castings of this description must be in a state of severe strain even when allowed to cool in the mould, and much more so, when cooled as evenly as is commercially practical, while the design may be so unnecessarily faulty, that even under test conditions of commercial practice the loss from cracks and checks may prove prohibitive in certain cases, and much too high in others. If the foregoing is true, what can be expected in the many cases that have been seen in which the castings have been stripped a few moments after solidification, with half of the castings buried in the still very hot sand and the other half exposed to the draughts of the foundry atmosphere. Not infrequently there will be seen a labourer wetting-down the sand on a floor adjacent to the one where the castings have just been stripped, and as he playfully looks around, the nozzle of the hose will partially swing around and drops of water will be sprayed over the red-hot castings, with the development perhaps of a check where each drop fell. Obviously, as the carbon is gradually lowered, both fluidity and contraction are adversely affected, but the author believes that there will be found to be little difference in these properties as between a carbon content of 2,50 per cent. and 2.35 per cent., but a more consequential and serious difference between a content of 2.35 per cent. and 2.00 per cent. While no manufacturer aims to run as low as 2.00 per cent. carbon, this figure accidentally may be reached when aiming to run on a content of 2.35 per cent. The point the author would bring out, is that from complaints investigated, he is forced to conclude that carelessness has contributed more to heavy crack and check loss than has a low carbon-content.

In the foregoing remarks on the air furnace, no efforts have been made to cover anything aside from the "high spots." With few exceptions, this is the furnace used in the States, owing to its cheapness and its simplicity of construction and repair. The open-hearth is much more costly to build, with the net result that no fuel economy results from its use owing to the fact, not that it it is not a more efficient melting apparatus, but that it must be kept hot when not in operation in order to prevent the spalling of the silica brick. The author does not believe that the use of the electric furnace is warranted, except perhaps in very large installations. There is no advantage to be gained in running on a very low-sulphur-phosphorus content, but quite on the contrary many disadvantages.

The Annealing Process.

In order to prepare the hard-iron castings for heat-treatment they are barrelled until free from

adhering sand and then trimmed. They are then placed in receptacles called pots or rings of the shape of a band in that they have neither top nor bottom. A ring is placed on a stool of solid iron about 3 in. thick and somewhat larger in perimeter, on the bottom of which are lugs about 5 in. high that serve as feet, and which are so spaced as to admit of the lifting fork of the charging truck being introduced beneath the stool. This ring is then filled with castings which are surrounded with a packing, the nature of which will be entered into later.

Another ring is placed upon the first one, and the process continued until four or five rings have been used, the entire assemblage being called a stand. These stands are then picked up by the charging truck, the best and most convenient form of which is the electric, and taken to the heat-treating oven, where they should be placed in straight rows, the row nearest the side wall being spaced at least 5 in. from it, and a space of 4 in. between the other rows. No mistake could be greater than to jam the stands close together, as it is of prime importance that heat circulation be given its greatest opportunity. The castings are surrounded with a packing for the purpose of preventing kiln-warp, and for the purpose also of furnishing an oxidising pot-atmosphere that will facilitate the decarbonisation of the metal. The latter object has been given an exaggerated importance as far as present-day practice is concerned.

In the old days, with castings having a carbon content of 3 per cent. or over, this may not have been the case, but with the carbon content now present a very strong packing is a mistake rather than otherwise. Even a packing of sand, if properly sized, will hold enough air to admit of all the oxidation necessary to produce a superior product. The really important matter is to have a packing preferably containing about 10 per cent. of iron oxides, the balance being of an inert character of the nature of slag, or other material that will have little tendency to combine with the oxides of iron at the temperature of anneal. The latter condition is important in order that there will be no tendency for the packing to lump, and in order that the casting readily can be shaken out clean and free from adhering packing. As a matter of fact, in muffle ovens of the very tightest construction, in which castings are packed solidly, so that the only unoccupied space in the muffle results from the voids occasioned by the castings, the decarbonisation is as complete as in the case of the strongest packing now used, as can be seen from Table I., which have reference to three test-bars selected on the authors last visit to a plant where no other type of oven is used.

Table I.—*Showing the Analysis and Physical Tests of Malleable Irons treated in a Muffle Furnace.*

Analysis of Hard Iron.

Mark.	Si.	P.	S.	Mn.	C.C.
1	0.76	0.193	0.050	0.200	2.13
2	0.88	0.180	0.051	0.230	2.26
3	0.80	0.190	0.049	0.200	2.37

Physical Test.

Mark.	M.S., tons per sq. in.	E., per cent. on 2 in.	R. A. per cent.
1	26.5	36.7	38.0
2	26.1	35.9	33.2
3	25.8	25.7	30.1

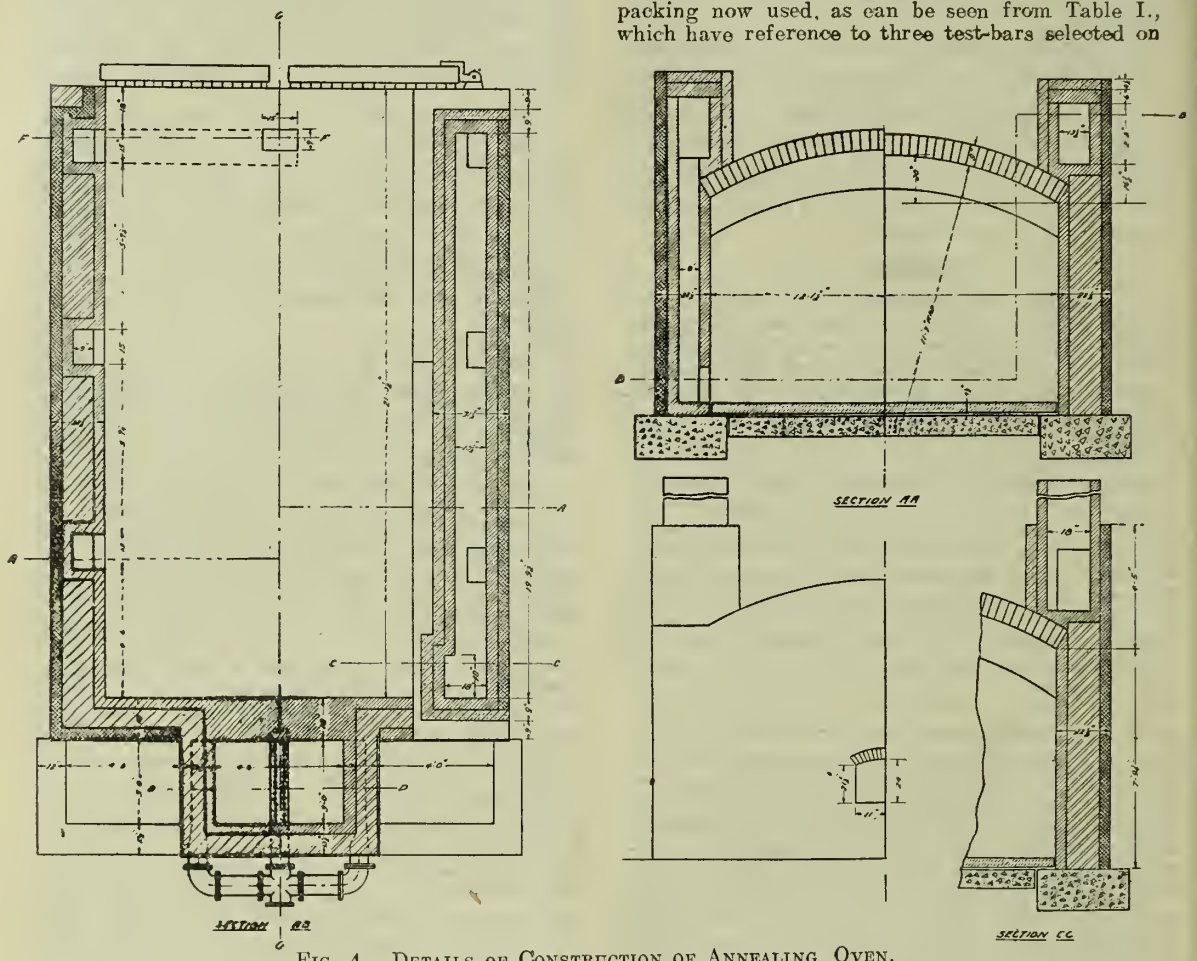


Fig. 4.—Details of Construction of Annealing Oven.

If castings are being made that are not liable to warp, the muffle-oven is the type to build. The best construction of muffle is by the use of the Manion type of brick. This brick is thin, but reinforced by webs that serve for the most part to carry the load, with the result that the heat can be transmitted to the inside of the muffle quickly and economically.

If the muffle is made of carborundum-brick a very strong and lasting muffle will result, through which the heat can be transmitted some six times more quickly than through a clay-product. These bricks are very expensive, and many have been deterred from their use on this account. A number of those who have consulted the author have been very sceptical in regard to the character of product that can be derived from the muffle oven. In order to quiet any who may feel likewise it can be stated that in the Association of which the author is consulting engineer one of the members makes use of the muffle-type oven only, and their record for quality is amongst the highest. As can be gathered from the tensile tests quoted in Table I., which happen to be considerably higher than their average, their product is not excelled by that of any

of the other. These particular results are quoted simply by way of illustrating what can be accomplished in the muffle oven. The product made by this particular concern will average about 24.1 tons per sq. in. ult. strength and run somewhat over 20 per cent. in elongation.

The Heat Treatment of Malleables.

As stated, in order to obtain a product high in tensile strength and ductility, the composition of the hard-iron castings must be restricted to within certain limits. Assuming that castings are being heat-treated that correspond to these composition requirements, it can be stated that, in order that their conversion into a product that is both strong and ductile, be complete and satisfactory as far as structural conditions are concerned, the castings preferably should be held at a temperature about 100 deg. F. (37 deg. C.) above the critical-range for a period of not much less than 60 hrs., and cooled

Essential Features of Annealing Ovens.

Space will not be used for recounting the conditions that prevailed, but a brief attempt will be made to cover certain facts that must be considered in annealing-oven design. First of all, each oven should be self-contained in all particulars. The general method, almost universal some few years ago and in no sense uncommon to-day, of building a battery of 8 or 10 ovens with common side-walls and a common stack is a serious mistake from many points of view. One can well imagine the unbalanced thermal conditions that must obtain when, as very frequently happens, two contiguous ovens are under fire but the one at their other side cold. In such cases the common side-wall of the two under fire is not exposed to the atmosphere, and consequently is radiating off no heat to it,

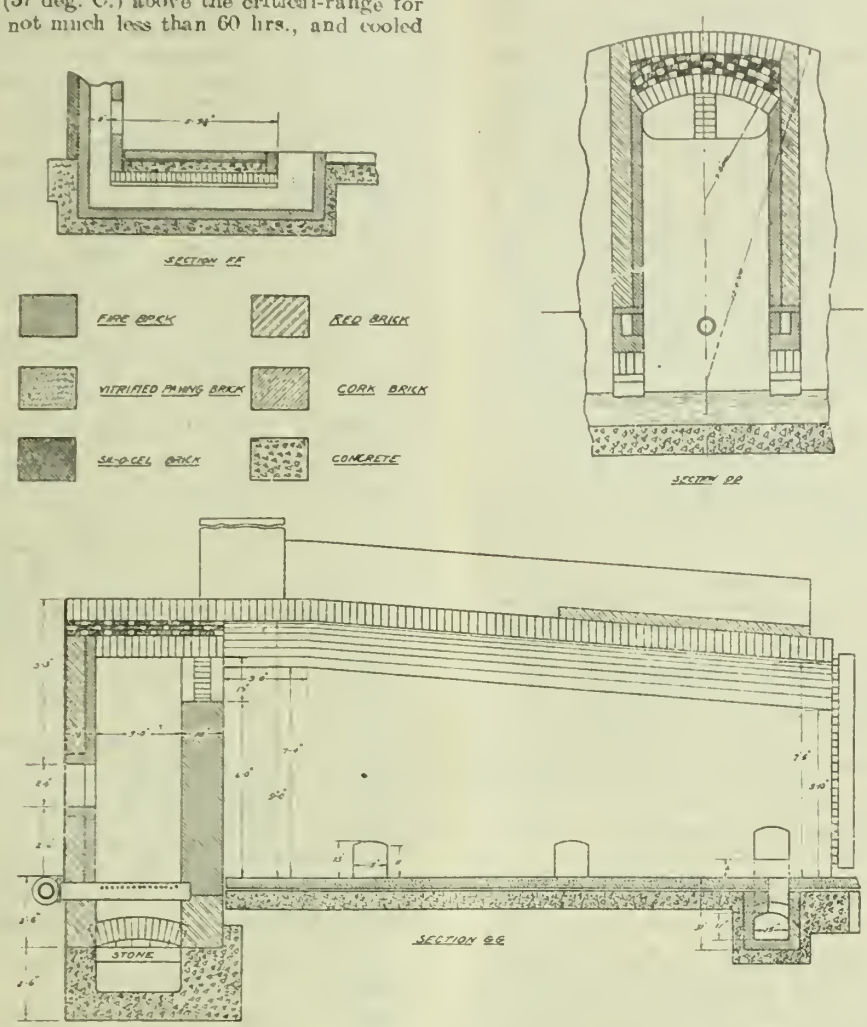


Fig. 4.

at a rate of 10 deg. F. (5 deg. C.) or less per hour, until their temperature has fallen to about 100 deg. F. (37 deg. C.) under the critical-range, after which the cooling gradually can be accelerated. It is one thing, however, to possess an accurate knowledge of exactly what should be done in order that the best heat-treating results will follow, and another to construct commercial apparatus in which a large quantity of material can be heat-treated in conformity with the rules that are prescribed. Some few years ago not only were most of the plants lacking in a metallurgical knowledge of the process, but the apparatus was of such a faulty character that it was impossible to carry out in an effective manner what research had shown was essential if the superior product was to be obtained. In short, it often is much easier to indicate than to achieve, and while general instructions can be sent out as to the proper temperature at which to convert, the length of time to hold at temperature, and the rate at which the cooling should take place, this will prove of little avail if the heat-treating ovens are so constructed that proper thermal conditions exist in only a restricted area of the oven, and that the oven as constructed cannot be cooled at the rate designated.

while the other side-wall is doing so at a rapid rate. Without wasting words to prove the general worthlessness of such construction, it briefly can be stated that from the standpoint of cost, maintenance, and control, this system could not be worse. Rigidity of construction is one essential that is fatal to overlook. If the ovens are not rigidly built cracks will develop and it will be difficult, and perhaps impossible, to cool the oven from temperature at the rate desired. The walls should be at least 22½ in. thick, encased on the outside with steel or iron plate, and the whole reinforced by a system of buck-stays set about 30 in. between centres where this is possible.

The walls and doors should be so thoroughly insulated that when the oven is at temperature the hand can be pressed against the plates without undue discomfort. The floor as well should be insulated and, for reasons to which we will refer later, so should the front half of the roof. The fire-pot of an oven should be on its outside and not within it, as the oven proper is designed to heat-treat castings and not for the purpose of burning coal. With the fire-pot on the inside and, as frequently is the case, located at one corner only, it is not an easy task, if at all possible, to

obtain heat uniformity within the oven, which statement holds true even in the event that a fire-pot is placed within the oven at diametrically opposite corners. The floor should be built solid, with no underground flue system beneath it. The latter construction is of no benefit as far as a saving of fuel is concerned, and with a complicated under-floor flue system—now being generally discarded as new ovens are being built—the cost of this part of the oven equalled if not exceeded that of the rest, while owing to the jar produced by the loaded charging truck and the combined weight on a floor subjected to such a high temperature the maintenance cost is heavy. No underground flues are necessary aside from one small stack-flue on each side of the oven, which preferably should be located on the outside, as close as practical to the side-wall footings. In the last few ovens designed by the author he has placed one stack-flue and one small stack on top of each side-wall, the bottom side-wall flue-openings being connected with these stack-flues by a vertical flue built within the side-wall.

In this manner not only is all underground flue work avoided, but as the entire system is exposed the flues can easily be kept clean and tight. The ovens are built in rectangular form, width and length in the ratio of about 3: 4. The fire-pot is located on the outside, midway between the side-walls, and is constructed on the gas-producer principle, that is, there is a water seal, air bungs through which about 400 cub. ft. of air per min. against a 5 oz. pressure is admitted, a more or less deep bed of coal resting on ashes that reach from the floor of the seal to about 1 ft. above the bungs. Between the actual roof of the fire-pot and the fire is a false arch, and between it and the roof chequer work of brick through which hot secondary-air for combustion of the combustible gases is drawn. These details are set out in Fig. 4. The opening from fire-pot to oven, that is, the bridge, is located as high as possible in order that combustion will start to take place right in front of the chequer work and at the point where the roof of the oven proper slants towards the front. Through the use of a slanting roof the bridge can be located so high above the top of the stands, where the temperature is obviously the hottest, that no danger exists in over-heating the castings in the topmost ring of the stand, while as the flame advances towards the front of the oven and its temperature drops by the amount imparted to the castings at any section, the roof is lower, and consequently a very close heat balance is maintained until the front of the oven is reached. There are three side-wall flue-openings at the floor-line, leading into the vertical flues that go to the stack-flue, with openings so proportioned that the heat of combustion is drawn to different parts of the oven in a very uniform manner, the adjustment being made by means of a draft-gauge in such a manner that the draft in the two front flue-openings is strongest but equal on each side, the next two less strong and equal on each side, and next still less strong and equal on each side. By means of this gauge and a pyrometer the adjustments can be made after some three or four anneals have been run.

(To be continued.)

Chemical Works Regulations.—The Home Secretary has issued, under date July 11, Regulations applicable to the manufactures and processes incidental thereto carried on in chemical works.

Protection of Steel Industry in Australia. — Outspoken remarks characterised the reply given by the Prime Minister (Mr. Hughes) to a recent deputation from the Australian Workers' Union, asking for further protection for the steel industry for about 18 months. Mr. Hughes asserted that it was not sufficient solely to protect an industry. There should be some assurance that the protected products would be bought. A duty of 100 per cent. could be placed on steel, but even then no one might be able to afford to give orders for the local material. England was producing steel despite the higher wages paid there as compared with those paid to German workmen, and he was sure that the difference in wages as between England and Australia was not so great as to account for the inability to produce steel locally. Mr. Hughes asked his hearers to place all the facts before the Tariff Board, which was a body clothed with extraordinary powers, and whose recommendations Parliament would not venture to disregard.

Trade Talk.

Bowers & Company, mechanical engineers, have removed from 37, Joseph Street, to 22, Bolton Street, Bradford.

Ball Brothers, ironfounders, of Stratford-on-Avon, have appointed Morse & Taylor, 124, Victoria Street, S.W., as their London agents.

The Joseph Dixon Crucible Company have removed from 28, Victoria Street, S.W.1, to 22, Duke Street, Stamford Street, London, S.E.1.

The Wooler Engineering Company, Limited, are being wound up voluntarily, with Mr. R. Stephens, 31, Lombard Street, E.C., as liquidator.

Steele Sellers & Company, iron and steel merchants, have removed from 5, Cathedral Yard, to 116, Cheetham Hill Road, Manchester.

The Brightside Foundry & Engineering Company, Limited, have removed their Newcastle branch offices from 14, Grainger Street, to 8, Oxford Street.

The Western Electric Company, Limited, have appointed Lionel Robinson & Company, 3, Staple Inn, W.C.1, sole selling agents for London, Middlesex and Surrey for their B.A.G. diffusers.

Mr. C. J. H. Carr Evans, Suffolk House, Laurence Pountney Hill, London, E.C.3, has been appointed British representative of P. Scholler & Sons, wire meshing manufacturers, of Hamburg.

Mr. L. F. Richardson, formerly connected with White Bros. Engineering & Machinery Company, Limited, Stratford, London, E.15, has established himself in business as a machinery dealer.

Ash & Lacy, Limited, Globe Galvanising Works, Great Bridge, Tipton, have appointed Morris Ashby, Limited, of 6, Chapel Street, Liverpool, as their selling agents in Lancashire and Yorkshire.

Messrs. John Cashmore, iron merchants, of Great Bridge, Tipton, Staffs., have purchased further obsolete war vessels, including a cruiser, two destroyers, and a submarine, for breaking-up purposes.

Considerable damage was caused by a fire which broke out at the works of Cochrane & Company, Limited, Cargo Fleet. The fire originated in the pipe-cutting shop, a building 45 ft. by 42 ft., and the foundry and pattern store were also damaged by fire.

The Mannesmann Tube Works, Burbach, Sarre, of which Engineering Supplies, Limited, Mansion House Chambers, 11, Queen Victoria Street, London, E.C.4, are the British representatives, having come under French control, will in future be known as Les Acieries et Usines a Tubes de Sarre.

The exhibits of Nobel Industries, Limited, at the Brazilian Centenary Exhibition, 1922, will be of a varied and interesting nature, contained in one large showcase. Generally speaking, the samples of Nobel products are exhibited under four heads—explosives, ammunition, metal goods, miscellaneous.

A. P. Townsend, iron, steel, etc., merchant, Exeter Buildings, Suffolk Street, Birmingham, has been appointed sole agent in the Midlands, Yorkshire, and South-West England, for the Dafen Tinplate Company, Limited, Llanelly, for tinned sheets, churn sections and circles, terne and lead coated steel sheets, and P.C.R.C.A.'s

Lawson, Walton & Company, Limited, 2, St. Nicholas Buildings, Newcastle-upon-Tyne, have established a foundry demonstration store and exhibition. This permanent exhibition will enable local foundrymen to inspect the various plant, equipment, stores, requisities, etc., necessary to the economical production of castings.

The Morgan Construction Company, of Worcester, Mass., U.S.A., have supplied eighteen additional Morgan producer gas machines to the Bethlehem Steel Company, Bethlehem, Pa., making a total of sixty-four erected at the Bethlehem works. The International Construction Company, Limited, 56, Kingsway, London, W.C.2, are the manufacturers of these machines in great Britain.

The Royal Metal Trades' Pension Society will in future be known as the Royal Metal Trades' Pension and Benevolent Society, the operations of the Society being extended to convalescent home treatment. The board of management have power to increase the pension to fifty guineas per annum, while females engaged in the trades are to receive consideration in accordance with the merits of the case.

The tender of Messrs. George Cohen, Sons & Company, Commercial Road, London, E., for the present accumulation and any quantities arising for a future period of at least six months of the surplus empty shells, scrap, etc., has been accepted by the Disposal and Liquidation Commission. The material is at present stored at various Government depôts throughout Great Britain, and clearance will commence almost immediately.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Training of Foundrymen.

To the Editor of The Foundry Trade Journal.

Sir,—"Equality of opportunity" appears to be the keynote of the suggested scheme for the training of foundrymen, outlined in the Paper given by Mr. A. A. Liardet, and reported in The Foundry Trade Journal, and if something on the lines suggested is carried into effect the foundryman of the future should worthily uphold the traditions of the industry, which nowadays are in danger of suffering an eclipse.

In engineering generally "equality of opportunity" is by no means pronounced, for the "pupil" and the "apprentice" are still separate and apart, and the future of the former differs considerably from that of the ordinary trade apprentice. Merit tells, but only to a limited degree, for the pupil is destined for a position, no matter how low may be his qualifications, whilst the apprentice, handicapped by the limited range of activity permitted by his training, is debarred from making a bid for position, and must perforce resign himself to the *rôle* of subordinate. In other words, one is trained to manage and control, whilst the other is trained to produce.

That this is an anomaly which should be discarded is recognised by many who have the interests of industry at heart, as well as the interests of the rising generation. When system prevents the exploitation of capabilities, by refusing the necessary facilities, it is injuring, not only the man, but also the industry with which he is associated. The man, by reason of his training, may be a sound and skilful workman, and as such is an asset to industry; but if his early opportunities had been more open, he might to-day have been an efficient manager, and a still greater asset.

"By merit alone shall he rise" should be the dictum employed, and no one will quarrel with the assertion that the development of proficiency will do much to allay industrial unrest. The workman, trained as a workman, must of necessity think and act like one, because he has not been trained to think and act differently, and he is proficient only as a workman. With better opportunities he might have done better, but as it is he must remain in the position for which he is fitted, and he grouses and kicks accordingly.

If the training of foundrymen is conducted on the lines suggested the "cinderella of the engineering industry should soon attract, and not repel; for even if, in the first instance, the boy does not appreciate the opportunities offered, the advantages to be derived will not be lost sight of by the parents. The mechanic (or foundryman) will see in this an opportunity for his son which was denied the parent, and will instil into the mind of the boy the advantages to be derived from constant application. No longer will the boy enter industry with a view to qualifying as a journeyman, but with a view to ultimately becoming a power; and even should he fail in after life to reach a high position, the training received will have broadened his outlook, and the bitterness of thwarted hopes and aspirations will not find expression in grumbling discontent with his lot, because he will know that the failure is his, and that he had the opportunity to do better.

The suggested probationary period of two years may have advantages, but it has its pitfalls also. The fact of being irrevocably bound for a number of years is apt to make the task distasteful, which prevents, to some extent, the development of capabilities, and the period of probation is presumably devised to allow the subject to retain freedom of action in embracing a career, by permitting him to take a more or less detached view of the surroundings. It may be said at once that this is a most critical period, and if the boy can stand the first two years of foundry life he will have no wish to relinquish that life at the end of the period. It is during that period that the determining factors are at work, and it behoves those who are responsible for the training of the boy to use this period for educational purposes of a practical nature. There is just as much danger in allowing the probationer too much freedom as there is in allowing him too little, and if he would be kept interested he must have something definite to do. He must feel, at a very early date, that he is part of the organisation, and that something depends upon him. If he is ignored, or left to shift for himself, his interest will speedily evaporate, and everything appertaining to foundry work will appear distasteful. The scheme is, however, a practical one, and deserves unqualified support.—Yours, etc.,

W. J. Hiscox.

London.

Gazette.

A winding up order has been made against the Clarendon Manufacturing & Engineering Company, Limited, 20, Copthall Avenue, London, E.C.

A receiving order has been made in connection with the affairs of Mr. L. I. Thomas, lately trading as the Valley Tinplate & Metal Company, 89, Taff Street, Pontypridd.

Messrs. J. T. Banner and G. F. Guy, iron, steel and mineral merchants, 31, Queen Street, Wolverhampton, have dissolved partnership, each partner in future carrying on business separately.

The partnership heretofore subsisting between Messrs. G. F. Johnson, W. Barras and W. Barras, engineers, Piccadilly, Shipley, Yorks, under the style of the Airedale Engineering Company, has been dissolved. Mr. Johnson continues.

The names of the undermentioned companies have been struck off the register of Joint Stock Companies, and such companies are dissolved:—British Sherardizers, Limited; Clayton Metal Company, Limited; Colonial Engineering Agency, Limited; Crescent Minerals, Limited; Denton Electrical Construction Company, Limited; Electro Galvanizers, Limited; Holmquist Electric Company, 1911, Limited; Humphris Engineering Syndicate, Limited; Humphries Patent Gear & Engineering Company, Limited; Leyton Engineering Company, Limited; Loughborough Ironworkers, Limited; Medina Engineering Company, Limited; North Stafford Silica and Minerals, Limited; Pioneer Engineering Syndicate, Limited; Reynolds Steel Inventions, Limited; Standard Turbine Company, Limited; Suffolk Iron Foundry Company, Limited; Victoria Stamping Works, Limited; and Woodward-Weddell Steel & Engineering Company, Limited.

Obituary.

Mr. B. Warren, of Warren Bros., boiler makers and colliery engineers, died on July 8, aged 65.

Mr. W. R. J. Griffiths, engineer, of Gungate, Tamworth, died recently at the age of 61 years.

Mr. H. E. Merry, engineer under the Swansea Harbour Trust, has died at his residence, 32, Carlton Terrace, Swansea, at the age of 37.

Mr. James Durrans, of James Durrans & Sons, Limited, manufacturers of foundry requisites, Phœnix Works, Thurlstone, Sheffield, died on July 15, in his forty-seventh year.

Sir James Brown Marshall died at his residence at Southsea on Saturday last. The deceased from 1906 to 1917 was Director of Dockyards at the Admiralty. He joined the board of Messrs. John Samuel White & Company, Limited, shipbuilders and engineers, at Cowes, five years ago as deputy chairman, and was afterwards elected chairman of the board. He was born at Portsmouth in 1853, and started life as an apprentice in Portsmouth Dockyard in 1867.

Mr. Robert Readhead, of South Shields, a well-known Tyneside shipbuilder, died on July 24 after a long illness. Mr. Readhead, who was in his 79th year, was the son of the late Mr. John Readhead, founder of the firm of John Readhead & Sons, Limited, shipbuilders. Marine engineering constituted his business career. He served an apprenticeship to that trade, and when, in 1865, his father founded the firm which has since become that of John Readhead & Sons, Limited, shipbuilders, engineers and graving dock owners, he was associated with it. For many years he was head of the engineering department, besides becoming one of the directors of the concern in the progress and development of which he took a prominent part.

IRON AND STEEL MARKETS.

Pig-iron.

Movements in the various pig-iron markets, as usually experienced at this period of the year, are restrained by the holiday influences, and business all round is quiet and uneventful. In the Midlands, consumption of pig-iron continues on a restricted scale owing to the general slackness in the foundry and finished material sections, in which, unfortunately, unemployment or short time working is still the rule. Buying in this district is consequently confined to immediate requirements, consumers hesitating about placing forward orders in the hope of securing some concession in prices when the revised railway rates come into force. Makers, on the other hand, contend that current market prices are unremunerative, and that the small advantage derived from the reduction of transport charges will not permit further concessions in the direction desired by buyers. In the Lancashire area rather more activity is noted in demand, foundries working on textile machinery castings having a fair volume of orders in hand, but otherwise business is quiet and consumption of pig remains at a very low average. Prices for Derbyshire No. 3 foundry, however, continue firm at previous quotations. On the Cleveland market conditions continue inactive, with few indications of a marked improvement in the near future. The home demand of late has been much below expectations as the result of the reopening of the engineering works, while the inquiry for export has also decreased in volume owing to the instability of the foreign exchanges. During July shipments of pig-iron from Tees-side ports have marked a decline as compared with June, the aggregate showing some 10,000 tons decrease in that period. So far, the restoration of freedom in price adjustments in the Cleveland market has had very little effect upon quotations. No. 3 G.M.B. is generally maintained at 88s., with No. 1 and silicious firm at 95s., while No. 4 foundry is a shade easier at 87s. to 87s. 6d.. No. 4 forge 85s., and mottled and white 80s. Purchases of ferro-manganese have been fairly extensive of late on American account, but there has not, as yet, been any development as regards foundry qualities in that direction.

The East Coast hematite market has undergone no improvement since previously reported, and stocks are now accumulating heavily. The arrangement between some of the local makers, by which the price of mixed numbers has been held at 94s. per ton, has now been modified to bring the quotation to 93s., but it is said to be possible to buy well inside these figures from firms outside the agreement.

Finished Iron.

In this section of the trade very little improvement can be recorded, the number of works still on short time evidencing the unsatisfactory conditions now affecting the industry, for which, at present, there is no relief in sight. In South Staffordshire also Belgian competition is again becoming active, makers in that country now offering nut and bolt bars at cut prices, with the result that home manufacturers have had to shade quotations in order to obtain business. The anomaly in prices of crown bars continues, some makers still adhering to £11 15s., and obtaining it for all the iron of this quality they sell, although the quantity is not large. Generally, however, the quotation for this quality is £11, and in some cases it is reported that that price is not firm. Transactions depend entirely on circumstances. Scarcity of orders may reasonably induce makers to grant concessions to keep works running, while those better placed for specifications are in the position to maintain firm prices. The foundry industry is also passing through an anxious period, but in this case hopes are confidently entertained that accelerated activity in the engineering branches may bring a speedy revival in the demand for castings. Wm. Whitwell & Company have reduced their prices of bar iron to £11.

Steel.

With the near approach of the holiday month business in all departments of steel production has slackened to some extent, although a steady stream of inquiries inspires optimistic anticipations of more favourable trade developments towards the end of August. At the moment, however, new orders are the subject of keen competition among steel makers, many of whom are, unfortunately, beginning to feel the financial strain of a prolonged spell of idleness, significantly expressed in the figures of balance sheets issued by many well-known firms, and dividends reduced or passed for the current year. In the heavier branches of the industry the delayed action of the companies in placing the long-expected orders for railway material has a restraining effect upon employment in the mills, forges and foundries, but these conditions it is hoped will soon be improved as renewal of stocks in that direction must now be a matter of urgency. Increased activity in the electrical industry is, however, a satisfactory feature in the position, the principal Lincoln firms in this line having substantial contracts on hand, which will entail some good orders for steel material. The placing of the Admiralty contracts for new battleships is also arousing interest among steel makers, Tyne shipbuilders and engineers awaiting instructions to tender for the new battleships and keen competition is expected. Armstrong, Whitworth & Company, Palmers Shipbuilding Company, and Swan, Hunter and Wigham-Richardson will tender, as will also R. & W. Hawthorn, Leslie & Co., and Parsons & Company. In South Wales the steel works are busy, but are anxious to increase their bookings. The Association price for steel sheet and tinplate bars is unchanged at £7 7s. 6d. The fixing of a price of £7 15s. for the Midlands has not been a success, owing to outside competition, and several orders have been lost by South Wales makers. Steel rails are very quiet, and the bulk of the business done has been in light rails.

Scrap.

In common with other raw materials, the markets for scrap are passing through an exceptionally quiet period, consumers restricting buying to parcels required for immediate necessities. On Tees-side heavy steel scrap is in slightly better demand, but material of the right sort is not plentiful, and the price is firmer at about 62s. 6d. per ton delivered at works. In other descriptions business is more or less stagnant, and prices are purely nominal as under, all delivered works:—Heavy cast-iron machinery scrap in handy pieces, 79s. to 80s.; steel turnings and cast-iron borings, each 45s.; heavy wrought iron, bushelling and piling, scrap, each 62s. 6d.; special heavy forge, 70s. to 75s. per ton.

Tinplates.

A somewhat easier tone has been in evidence in the tinplate market during the current week, but values, on the whole, have been steadily maintained. The export trade continues quiet all round, but buying on home account shows a fair average volume of business passing. Standard sizes are now quoted:—Coke tins, IC. 14 x 20, 112 sheets, 108 lbs., 19s. 6d. to 19s. 7½d. per box; IC, 28 x 20, 112 sheets, 216 lbs., 39s. to 39s. 6d. per box, net cash, f.o.b. Wales, the higher figures being asked for prompt shipment. Wasters are in quiet steady demand, with few variations from previous quotations.

Metals.

Copper.—In view of the impending holiday season business in the markets for base metals has tapered off to a considerable extent, and with relaxed pressure of buying transactions have in general been confined within narrow compass. Notwithstanding the conditions thus outlined, the tone of the standard copper market has held firm, and with consumers showing an increased disposition to buy forward, more activity in dealing is promised in the near future. Labour disturbances in the States have had a depressing effect upon business on that side, but the tone in the New York market continues steady, with a fairly substantial demand, which, eventually, must have the effect of considerably reducing stocks recently accumulated. Current quotations:—

Cash: Wednesday, £63 7s. 6d.; Thursday, £63 12s. 6d.; Friday, £63 17s. 6d.; Monday, £64 5s.; Tuesday, £64 12s. 6d. *Three months*: Wednesday, £63 12s. 6d.; Thursday, £63 17s. 6d.; Friday, £64 2s. 6d.; Monday, £64 7s. 6d.; Tuesday, £64 15s.

Tin.—An outstanding feature in the week's transactions in standard tin has been a revival of buying on speculative account, with almost daily advances in values, the anticipated disposal of stocks in the East not apparently having materialised. It had also been feared at one time that the American coal and labour troubles would affect the market, but it is now expected that the American deliveries will turn out well for this month, and there continues to be influential buying of the metal. Owing to pressure in near positions the premium on forward tin has now entirely disappeared. The Straits shipments this month are

expected to be considerably smaller at about 4,500 tons. The latter factor will, of course, have an effect upon the statistical position of which the figures for the past month may be more favourable than market expectations. Current quotations:—

Cash: Wednesday, £160 5s.; Thursday, £162 15s.; Friday, £161 10s.; Monday, £162 10s.; Tuesday, £162 15s. *Three months*: Wednesday, £160 5s.; Thursday, £162 15s.; Friday, £161 10s.; Monday, £162 10s.; Tuesday £162 15s.

Spelter.—Better buying of the metal by the galvanising industry of late has had a stimulating effect upon the spelter market, and prices are firmly upheld. Supplies of electro are again restricted, and here again values have again appreciated. The American position continues strong. Current quotations:—

Ordinary: Wednesday, £29 17s. 6d.; Thursday, £30 7s. 6d.; Friday, £30 10s.; Monday, £31; Tuesday, £31 10s.

Lead.—The stringency in soft foreign pig remains unabated, and backwardation is once more much in evidence. Little metal is available for export, and Continental consumers are consequently mainly dependent on supplies from Spain and Australia. More business in sheet and pipe lead has been done with the building trade, while the cable manufacturers have also been taking considerable quantities. Current quotations:—

Soft foreign (prompt): Wednesday, £25 2s. 6d.; Thursday, £25; Friday, £25 17s. 6d.; Monday, £25 15s.; Tuesday, £25 12s. 6d.

Company News.

Consett Spanish Ore Company, Limited.—Final dividend, 1s. per share.

Hadfields, Limited.—Interim ordinary dividend, 6d. per share, free of tax.

Consett Iron Company, Limited.—Final ordinary dividend, 4 per cent., free of tax.

National Gas Engine Company, Limited.—Interim ordinary dividend, 7½ per cent. per annum.

Ludlow Brothers (1913), Limited.—Interim dividend on preference, 6 per cent. per annum, less tax.

E. G. Wrigley & Company, Limited.—Directors state that there is £48,000 which they consider desirable to write off stock.

Herbert Morris, Limited.—Half year's dividend on 6 per cent. (less tax) and 5 per cent. (free of tax) cumulative preference shares.

Sutton Ironworks, Limited, 75, Evershot Road, Stroud Green, London, N.—Capital £2,000. Directors: J. W. Abraham, F. G. Small, and E. H. Tustain.

Samuel Heath & Sons, Limited.—Profit, £10,423; brought forward, £14,568; available, £24,991; final ordinary dividend, 5 per cent., free of tax; carry forward, £18,316.

Parkinson & W. and B. Cowan, Limited.—Net profit, £30,392; brought forward, £19,731; final dividend, 5½ per cent., making 8 per cent. for year; benevolent fund, £600; carried forward, £2,706.

Caton Machine Tool & Engineering Company, Limited, 49, Waterloo Street, Leeds.—Capital £4,000 in £1 shares (1,000 preference, 2,000 ordinary, and 1,000 deferred ordinary). Directors: C. H. Caton and J. W. Rawling, Junr.

Wrentmores Amalgamated Engineering & Construction Company, Limited.—Capital £12,500 in 10,000 12½ per cent. cumulative preference of £1 and 50,000 founders' of 1s. each. Directors: Lt.-Col. C. H. Versturme-Bunbury and Dmitri Tchernine.

Vivian D. Llewellyn & Company, Limited, 9-10, Western Mail Chambers, Cardiff.—Capital £500 in £1 shares, to take over the business of an electrician, engineer, etc., carried on by Vivian D. Llewellyn. Permanent directors: F. Thompson and V. D. Llewellyn.

Warner & Company, Limited.—Profit, £11,122; appreciation in value of investments, £5,207; brought forward, £1,727; balance, £18,056; ordinary dividend, 20 per cent. (less tax), making 22½ per cent. for year; depreciation (property, plant, etc.), £1,000; carried forward, £1,880.

R. & W. Hawthorn, Leslie and Company, Limited.—Depreciation, etc., £29,480; available balance, £203,427; interim dividend, 6d. per share, free of tax, £17,913; final dividend, 1s. 6d. per share, free of tax, £53,741; future extensions and improvements of plant, etc., £45,268; reserve fund, £60,000; carry forward, £31,503

Normanby Iron Works Company, Limited.—Interest received and other income, £14,775; debenture stock interest, £2,263; directors' fees, £1,234; brought forward from last year, £1,346; preference dividend, 6 per cent. for year, £3,600; interim ordinary dividend, 6 per cent., £3,000; balance, £5,423; equalisation of dividend account, £1,000; final ordinary dividend, 6 per cent., making 12 per cent. for year, £3,600; carried forward, £823.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING PLUMBAGO CORE GUM WHITE DUST COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	64	12	6
Three months	64	15	0
Electrolytic	71	0	0
Tough	66	10	0
Best selected	66	10	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	15	0
Do. Aug.	71	15	0
Do. Sept.	71	15	0
Ingot bars	71	10	0
H.C. wire rods	76	0	0
Off. aver. cash, July	63	3	7 3/14
Do. 3 mths., July	63	10	5 5/14
Do. Settlement July	63	3	2 4/7
Do. Electro, July	71	0	0
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July	71	13	7

Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.
Yellow metal rods	6½d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9½d

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13d
Rods, drawn	10¾d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	9¾d.
Wire	9¼d.
Rolled metal	9¼d.

TIN.

	£	s	d.
Standard cash	162	15	0
Three Months	162	15	0
English	162	15	0
Bars	164	10	0
Chinese	161	0	0
Straits	163	5	0
Australian	163	5	0
Eastern	164	10	0
Banca	162	12	6
Off. aver, cash July	156	4	4 1/7
Do. 3 mths. July	156	14	5 1/7
Do. Sttlment July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

	£	s	d.
Ordinary	31	10	0
Remelted	29	5	0
Hard	23	0	0
Electro 99.9	35	10	0
English	31	7	6
India	23	10	0
Prime Western	31	5	0
Zinc dust	45	0	0
Zinc ashes	8	0	0
Off. aver., July	28	18	5 1/14
Aver., spot, July	29	0	10¾

LEAD.

	£	s	d.
Soft foreign ppt	25	12	6
English	26	15	0
Off. average, July	24	6	11¼
Average spot, July	24	17	4½

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	36	0	0
Do. V.M. ex. whf	36	0	0
Dutch	36	0	0
Rods	41	0	0
Boiler plates	34	0	0
Battery plates	34	10	0

ANTIMONY.

	£	s	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	24	5	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 5 0 to 11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s	d.
Ferro-silicon—			
45/50%	13	0	0
75%	23	0	0

Ferro-vanadium—
35/40% 17/6 to 17/9 lh. va.

Ferro-molybdenum—
70/75% 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23

Ferro-chrome—
Max. 2% car. .. £65
Max. 1% car. .. £75
Max. 0.70% car. .. £90
67/70%, carhonless 1/8 lb.

Nickel—99%, cubes or pellets £155

Cohalt metal—98/99% 10/6 lh.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb

Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carhonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished hars, 14% tungsten	2	6
Finished hars, 18% tungsten	3	0

Per lb. net, d/d huyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb,
Flats under 1 in. by ⅛ in. to ½ in. hy ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d

Per lh. net, d/d steel makers' works.

SCRAP

	£	s.	d.
South Wales—			
Heavy Steel	3 7 6	3 15	0
Bundled steel & shearings	2 18 0	3 7	6
Mixed iron & steel	2 17 0	3 5	0
Heavy cast iron	3 7 6	3 15	0
Good machinery for foundries	4	0	0
Cleveland—			
Heavy steel	3	2	6
Steel turnings	2	5	0
Cast-iron borings	2	5	0
Heavy forge	3	12	6
Bushelled scrap	3	2	6
Cast-iron scrap	3	19	6
Lancashire—			
Cast iron scrap	4	0	0
Heavy wrought	3	10	0
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	55	10	0
Brass (clean)	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	65	0	0
Braziery copper	46	10	0
Gun metal	40	0	0
Hollow pewter	120	0	0
Shaped black pewter	70	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	88/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	94/-
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold hlast	240/-
,, hasic	—
Northants forge	70/- to 72/6
,,foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derhyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	106/-
,, No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derhy forge	82/6
,, foundry No. 3	86/6
,, hasic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, hasic	86/6
E.C. hematite	104/2
W.C. hematite	107/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (crown)	£10 10 to £12		
Angles	£11 to £12	10	0
Tees to 3 united ins.	£11 10 to 13	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ⅝ in. × 4 in.	20	10	0
Steel—			
Ship plates	10	0	0
Boiler plates	13	10	0
Chequer plates	10	10	0
Angles	9	10	0
Tees	10	10	0
Channels	8	15	0
Joists	10	0	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1½in.	8	10	0

	£	s.	d.
Rails, heavy	9	10	0
Fishplates	14	10	0
Hoops	12	0	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	0	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	14	0	0
Billets, soft	7 0 0 to 7	7	6
Billets, hard	8	0	0
Sheet hars	7 5 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb hasis.
Strip	1 3
Sheet	1 3¾
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lh.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6½ to 2/0½
To 18 in. wide	1/7½ to 2/1½
To 21 in. wide	1/8½ to 2/2½
To 25 in. wide	1/9½ to 2/3½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	27.64
No. 2 foundry Valley	24.00
No. 2 foundry, Birm.	18.00
Basic	25.96
Bessemer	26.77
Malleahle	26.46
Grey forge	25.27
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. hillets	35.00
O.-h. hillets	35.00
O.-h. sheet hars	35.00
Wire rods	40.00
	Cents.
Iron hars, Phila.	1.92
Steel hars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.70
Skelp, sheared steel	1.70
Steel hoops	2.50
Sheets, hlack, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barhed wire, galv.	3.05
Tinplate, 100-lh. hox	$4.75

COKE (at ovens).

Welsh foundry	32/6
,, furnace	22/6
Durham & North. foundry	28/-
,, furnace	22/6
Other Districts, foundry	27/6
,, furnace	22/6

THE

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Contents.

	PAGE
Mr. Cook's American Exchange Paper	109
The Metallurgy of Semi-Steel	110
An Apprenticeship Course in Foundry Practice—IV.	115
New Suggestions for Notched-Bar Tests	117
The Development and Manufacture of High-Tenacity Brass and Bronze	118
Safety in Pulverised-Coal Plants	121
American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product	122
Trade Talk	125
Company News	125
Iron and Steel Markets	126

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Mr. Cook's American Exchange Paper.

The written discussion on Mr. Cook's paper on American *versus* British Cast Iron, which we printed in our issue of July 20, is most illuminating. The strongest support for Mr. Cook's assertions is given by Mr. Steven B. Phelps, of Pittsburgh, who, whilst pointing out that the paper contains many statements that American foundrymen and engineers know to be incorrect, if it is inferred that the castings cited represent standard American practice, finishes up his remarks with an apologia, blaming war conditions. Mr. H. J. Young, of Wallsend, who assumed Mr. Cook ascribed the superiority of British castings to inherent properties, as usual did not deny the possibilities of these qualities in pig-iron, but emphasised the fact that he still awaits proof and points out that he can reproduce a definite quality of casting by using a considerable variety of brand of pig-iron, based on chemical composition. As is well known, Mr. Young will not admit of stabilised cupola conditions, and undoubtedly there are factors which are beyond control, such as moisture carried in with the blast and the maintenance of the height of the bed from the beginning to the end of the blow. Control of casting temperature and rate of cooling down undoubtedly present other difficulties. But in spite of this, Mr. Young asserts that he himself would, with the greatest confidence, undertake to prove it (that Americans could produce castings of a grade equal to British) without any question of pig-iron possessing or not possessing inherent qualities.

Dr. Moldenke's criticism lends support to Mr. Cook's conclusions in so much as he points out that Germany (and for that matter most European countries) buy British irons when they require high-grade material. Here, inherency spreads to commerce, for we have every reason to believe that the Germans are fully alive to mixing by analysis. They, too, during and just after the war, "struck a bad patch" in their foundries, their trouble being hard white spots. Always in conversations of this nature the question of oxygen and gases comes up for consideration, but really, in the present state of our knowledge, oxygen and inherent properties are on a par, that is, little or nothing scientific is known about either. Dealing with mechanical testing, Dr. Moldenke states that he is puzzled at the summary of British practice as presented by Mr. Cook. His actual words are: "With us here, the Keep method is considered so antiquated that it may only be found sporadically in stove shops as yet. With all due respect to the attainments of Mr. Keep, whom many of us remember, and whose friendship we valued highly, none the less his usefulness as a guide ended when he refused to adjust himself to the, for him, uncomfortable facts brought out by foundry metallurgy. Possibly it is this study of cast iron in the light of the engineer rather than as engineer and metallurgist that makes me wish that Mr. Cook had explained why Britain still uses square and flat bars cast horizontally rather than round ones cast vertically. You have only to do as I have done—slice the flat bar into three, longitudinally, and test each unit, to see how different the metal at the corners and the edges is from that in the middle. We have still one branch of the foundry industry using a flat bar, and this industry is now considering the advisability of getting up to date."

With regard to this last phrase, we would revert to a statement in Mr. Young's discussion. He says: "It has long been the writer's opinion that the greatest stumbling-block to America's progress in ordinary grey cast iron is their tapered test-bars cast separately." With regard to his remarks about Keep we would point out that it is the opinion of some brilliant foundrymen that this investigation spoilt some of his work by modifying his diagrams to make them fit in with another research worker's conclusion. Mr. Ronceray has dealt with this in a communication on Mr. Cameron's paper on semi-steel, which is dealt with elsewhere in our next issue.

MR. D. M. MOWAT, general manager of the Summerlee Iron Company, Limited, Coatbridge; Mr. William Graham, furnace engineer; Mr. William Howat, furnace manager; and several of the men were severely burned as the result of an ignition of gas on the top of No. 3 furnace at the Summerlee Works.

The Metallurgy of Semi-Steel.

By David McLain.

The author may be thought to be presumptuous and egotistical in daring as an American to address Britishers on the science of melting iron and steel or wrought scrap in cupolas, as some have been doing it very successfully for years, but please remember there is no more electricity in the world to-day than there was years ago, and until someone recognised the law by which it could be made of service, we knew but little of it. To-day the world is lit up by it. Just so as with the laws governing the science of melting steel scrap in cupolas, it took someone to prove that (1) steel scrap will *not* reduce total carbon; (2) steel scrap will *not* cause hard spots; (3) manganese is *not* a hardener; (4) high blast is *not* required; and although the author demonstrated all this twenty or more years ago, many writers to-day still claim steel will reduce carbon, and that is the main reason for the author's presence in Great Britain.

Writers for technical papers have advised foundrymen that it is necessary to use cold-blast pig, hematite pig, cerium, titanium, vanadium and other alloys if they want to make quality castings.

Others have also been advised to melt iron in the electric furnace, the air furnace, and the open-hearth furnace, and that quality iron, semi-steel and steel can be made in the electric furnace from cheap borings and turnings, but the cupola, in the hands of competent operators, can produce quality metal using steel and wrought scrap and other materials.

The cupola is considered a mysterious piece of equipment by many, who compare it to a bucking horse. They pose as authorities, but they "let George do it," and if the metal is good they take the credit, but if it is of poor quality they blame George for it.

Potentialities of Semi-Steel.

We believe this subject should be discussed to a satisfactory conclusion, as engineers and foundrymen throughout the world are guided by writers who should know that good semi-steel of ½ in. section is stronger and will resist hydraulic tests better than the average grey iron of 1-in. section.

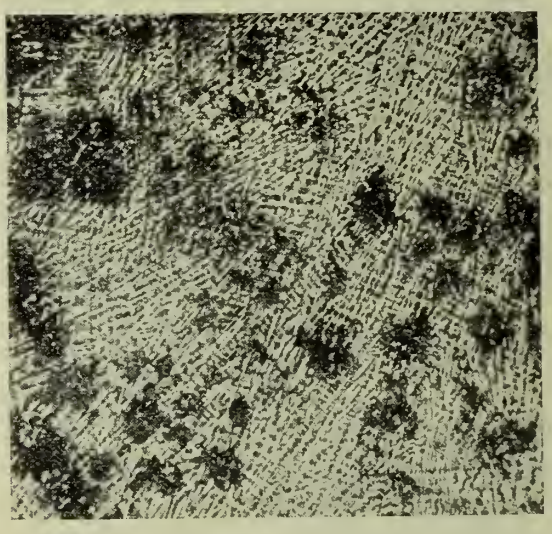
Initially it may be as well to submit a few facts concerning the absorption of carbon by the steel from coke. When a boy the author learned that steel absorbed carbon from a facing sand containing coke. Open-hearth steel of 0.20 to 0.30 per cent. carbon poured in gear blanks made of this facing were considerably higher in carbon on the exterior than the interior.

Taking advantage of this knowledge, the writer made tramcar wheels, using this coke facing on the tread, and after outwearing several sets of grey iron wheels, a large order was placed for similar wheels, being designated on the specifications as "chilled steel wheels." A steel rod in a blacksmith's fire showed signs of melting one day, and investigation proved that that rod had been in the fire frequently, absorbing carbon each time, until eventually the melting point was lowered to that of grey iron.

The ancients learned that a lump of iron ore thrown on an open fire, heated to redness and hammered, would develop into a spongy mass of iron that could be hammered to form implements of war, and modern chemists have analysed swords made by the ancients, finding there was 1 to 2 per cent. carbon present, this proving conclusively that wrought iron or steel will absorb carbon when heated in the presence of a carbonaceous fuel, so the writer experimented with coke and steel scrap in cupola mixtures, and was agreeably surprised to learn that steel will absorb up to 3 to 5 per cent. carbon, depending on the melting conditions. Synthetic pig-iron would be impossible except that the steel turnings absorb carbon from the coke.

Making semi-steel, like other things, depends on knowing how. Take Hadfield's process of producing manganese steel. Without his formula and instructions, the "man in the street" could not make it. The author has met many who tried to make manganese steel, but failed in the attempt. Should manganese steel be condemned on that account? Similar conditions exist with semi-steel. Some people try to make it without the proper instructions, and the resultant metal being full of hard spots or blow holes, they condemn semi-steel. One converter steelfounder may make good steel using 60 to 90 per cent. steel scrap, because he knows how to melt it and control the sulphur, while his competitor may use 50 per cent. pig-iron and still be unable to meet the specifications.

Micro. No. 1 is taken from the thick end of Wedge No. 1—Cast-iron.



Micro. No. 2 is taken from the thin end of Wedge No. 1.

The magnification in all the micros. is the same—150 *dias.*

Rapid Advance in Metallurgy.

For 50 years previous to the time it was discovered that carbon is absorbed from coke when making semi-steel, very little progress was reported by grey iron foundrymen.

The greatest developments in grey iron foundry practice are traceable to the introduction of steel scrap in cupola mixtures and commonsense methods of mixing and melting; in fact, to one like the author, who has been on the firing line for approximately half a century, it appears as if there has been 100 years' advancement within the past quarter century.

False Claims.—Many text-books, whether by technical or practical men, have maintained that steel reduces carbon. Chemists and metallurgists and practical foundrymen have at times agreed

that (1) steel causes hard spots, (2) will not mix with iron, (3) is not a good thing to use, (4) requires a higher melting temperature, and that (5) manganese is a hardener. The use of steel in cupola mixtures was questioned on all sides, but we learned that carbon will be absorbed from fuel by the steel up to the saturation point, and that manganese above a certain point aids in increasing the saturation point of iron for carbon.

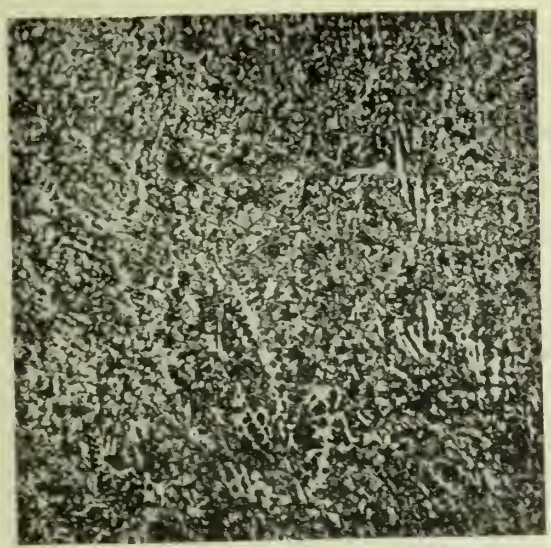
The author has had hundreds of analyses made of both grey iron and semi-steel to learn whether there is less total carbon in semi-steel compared with grey iron, but there is not sufficient evidence to substantiate the claim that steel will reduce carbon.

Carbon Acts as a Medium.

As carbon acts as a medium through which the other elements work, we do not try to remove it from iron, but learn to regulate it by studying the effects produced by silicon, sulphur, phosphorus and manganese. Study the effect of high and low blast on the carbons, and use this knowledge to advantage when calculating mixtures for different castings that require softness, strength, fluidity or chill.

In melting iron in the cupola, carbon will be absorbed from the fuel when a mild blast is used, and the amount absorbed will depend on the amount of carbon in fuel, the power of material to absorb carbon, and the temperature at which iron is melted.

This point alone should enable the student to realise the importance of becoming thoroughly



Micro. No. 3 is taken from No. 1 Wedge in an intermediate position.

alive to cupola operation. When poor coke and high blast are used carbon is lost, and as the total carbon is lowered combined carbon increases in proportion to this loss.

When melting steel for cupola mixtures, high-carbon coke is used for fuel. Coke, of course, can also be used in crucible melting, but in this practice the metal does not come in contact with fuel, therefore does not absorb carbon from it. On the other hand, steel melted in the cupola comes in intimate contact with the fuel, and owing to the very low percentage of the different elements in the steel, it has a strong affinity for them, particularly carbon.

When steel is heated to redness it begins to absorb carbon from the coke, and will continue until they both become incandescent, when the carbon may be 5 per cent.; consequently, it automatically increases the temperature of the melting zone above that of the highest temperature necessary to melt grey iron, and blends with the balance of the mixture.

While it is claimed that the carbons are the predominating elements in iron castings, it is impossible to produce chill castings with high silicon, say, 2.75 per cent.; in fact, the skilful metallurgist insists that silicon be 2.00 per cent. or less to produce a very thin chill, known as a "skin" chill on light castings.

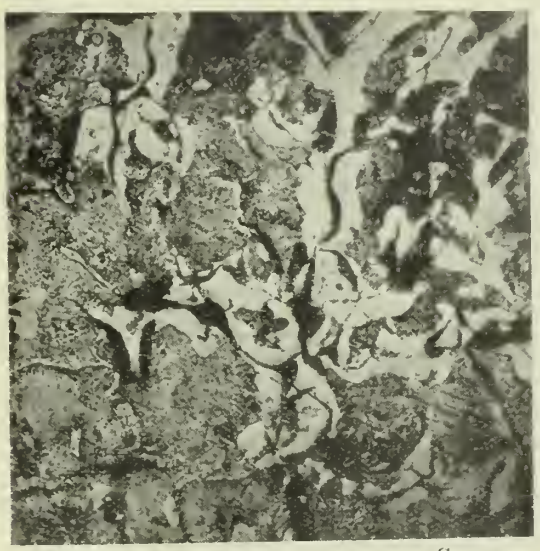
The results of thousands of tests, both physical and chemical, lead one to believe that silicon is the controlling element, although sulphur, phosphorus and manganese play their parts along with the length of time the casting is allowed to cool in mould—all of which have a decided influence on the ultimate proportions of either graphite or combined carbon.

Keep and others claimed that the carbon in liquid cast iron is all in the combined form, but this, as well as the claim that steel scrap, when added to cupola metal, will reduce carbon, did not appeal to the author.

Condition of Carbon in Liquid Cast Iron.

Keep claimed that graphitic carbon is only precipitated from the combined carbon by slow cooling, but the author has poured castings 1-16 to ⅛ in. thick of 2.75 per cent. silicon iron, when the metal sets or freezes almost instantly. If carbon in liquid iron is all combined, one could hardly expect a precipitation of the graphitic carbon instantaneously, but analyses proved that the carbon was practically all in the graphitic form, consequently the castings were soft.

On the other hand, take a 1.75 per cent. or less silicon metal—pour it into castings 1-16 to ⅛ in., and the castings are hard with 0.50 or more per cent. combined carbon. It might be reasoned that the higher silicon iron may not have set as quickly as the lower silicon iron, but it is a well-established fact that the lower silicon iron will produce hard castings of thin sections, while the



Micro. No. 4 shows that the Graphite Flakes are smaller in 10 per cent. semi-steel. It is taken from the thick end of No. 2 Wedge.

same sections poured of higher silicon will produce soft castings.

There is no graphitic carbon in steel or white iron because there is very little silicon, so no doubt Keep referred to steel or white iron—not grey iron—when he made the remark that the carbon was all in the combined form.

Semi-steel is the connecting link between iron and steel—combining the fine-wearing qualities of iron with a tensile strength of 19 to 23 tons when using 30 to 50 per cent. steel scrap in medium and heavy sections, and we justly claim it is one of the most valuable products of the grey iron foundry.

Merits of Semi-Steel.

Next to monkeys, man is the greatest imitator, so he watches other men charge steel scrap in the cupola, returns to his shop and does likewise, but not knowing the laws governing the operation he makes a mess of it. If the castings are passable, perhaps soon he is claiming to make semi-steel using half steel scrap.

Now this half-steel claim recalls the story of the man who made a fortune through his famous rabbit pies. A competitor started, but his pies were not so good although he sold large quantities.

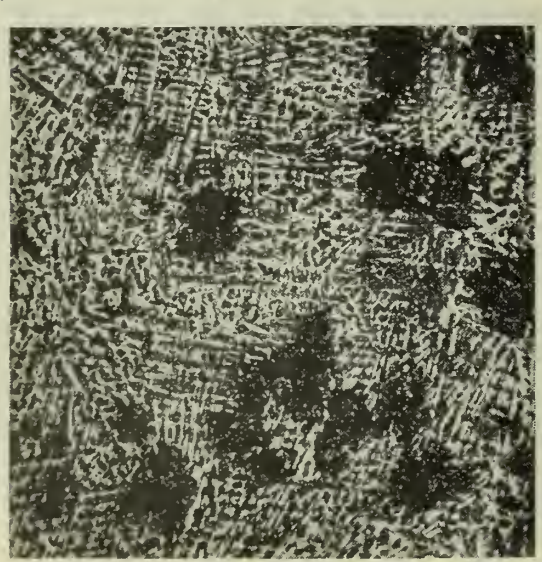
One day a friend asked him what he was using,

and he said "horse meat and rabbits." "Why," his friend says, "rabbits are very scarce, how do you manage it?" "Oh! I use a 50-50 mixture." "What?" his friend says, "half horse meat and half rabbit?" "Oh no, one rabbit mixed with one horse." And that about hits many foundrymen who claim to use large percentages of steel.

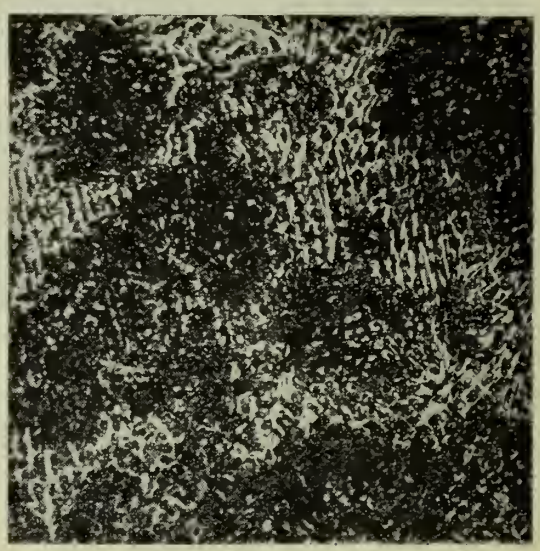
It is only those who recognise the laws of good melting, the merits and advantages of semi-steel, and place themselves in harmony with them, who share the commercial benefits of strong, clean, homogeneous castings and minimum losses—the delight of every true foundryman and engineer.

When properly made, semi-steel exceeds in both temperature and fluidity any other mixture melted in the cupola. The oxidation of the steel when melting scientifically is scarcely perceptible, and when steel is heated in the presence of coke it begins to absorb carbon from the coke, faintly at low temperature, but as the temperature is increased and the steel and coke become incandescent, the steel absorbs large percentages of carbon and no longer is the steel of commerce, but a highly carbonised metal, and will melt before the pig iron in the same charge.

The use of steel in cupola mixtures was questioned on every side—but all such theories were exploded when it was proved that carbon would be absorbed by the steel up to the saturation point, and that manganese above a certain point assisted in increasing the saturation point of iron for carbon, as steel fuses perfectly and it has a strong affinity for carbon, silicon, sulphur, phosphorus, and manganese—proving to the metallurgical world that steel improves the product and that a new principle was discovered and applied with astonishing results.



Micro. No. 5 relates to the thin end of Wedge No. 2.



Micro. No. 6 is taken from Wedge No. 2 in an intermediate position.

Semi-steel is made in the same cupola—in the early or the last part of the same heat with ordinary grey-iron mixtures—no extra coke, special appliances, fluxes, or new equipment are necessary.

Mixtures may contain 30 to 40 per cent. steel on the bed charge—then follow with 20 to 25 per cent. steel—or begin with a small percentage of steel and finish with a large percentage. Flexibility of operation is only one of the many advantages of semi-steel.

Development of Semi-Steel.

There is no subject so interesting to the foundry world to-day as semi-steel, and while a great many are trying to improve their product, they cannot believe that scientific principles govern the ultimate result—even before the materials are charged into the cupola.

The object of this article is to give some plain truths about semi-steel. Many of the statements deal with historical facts dating back fifty years, while many points set forth may be disputed.

For fifty years or more foundrymen have added steel to iron in the ladle, while comparatively few melted slight amounts of steel in the cupola.

A patent was granted in England more than fifty years ago on a cupola mixture which contained only 10 per cent. wrought scrap. Major McDowell was quite successful in using steel scrap in castings of heavy section, but up to 1902 or 1903 the author could find no record of any man having used large percentages of steel in castings of light section.

The author perfected his formula of using large percentages of steel in light sections, and thus developed what he believes is a new metal in 1903—and instead of giving it a fancy name, called it "semi-steel."

The author does not claim to be the first man who used steel in cupola mixtures, but no previous record has been found relating to the successful use of large percentages of steel scrap in castings of light section, and he has taught his process to foundrymen in various parts of the world since 1903.

Nomenclature.

The name "semi-steel" has been abused for years, and will continue to be abused as long as men are satisfied with a mere superficial knowledge. A misapplied and misapprehended term is sufficient to give rise to fierce and interminable disputes; the term "misnomer" has often turned the tide of popular opinion; and while various authors have tried to place semi-steel on the list of misnomers, still the very fact that semi-steel was specified for shells by the Allied governments has placed it as a standard for foundrymen everywhere.

Many claim there is no such thing as semi-steel—that the steel loses its identity and is only grey iron. They forget that pig iron is used to make steel, and while the iron loses its identity they call the resultant metal "steel."

Foundrymen and engineers have also been advised "cast iron is cheap, and heterogeneous, therefore use heavier sections." This dictum has many followers, who are led to believe *one* standard mixture should be used for the entire heat, whether castings are light, medium, or heavy.

Microphotographs of Wedges showing Fallacy of Casting Different Sections from one Grade of Metal.

An experiment which the author believes will prove of great interest to foundrymen is what is called "the wedge test." A pattern is made 16 in. long 2 in. square on one end, tapered to a feather edge 2 in. wide similar to a wedge. A few are moulded and cast from several different mixtures, which correspond to the metal poured in the various castings. The wedges are broken at sections which correspond to different sections of castings and the fracture noted. It will prove that it is a serious mistake to pour castings of different sections of one mixture.

If it is learnt that the metal of ½- 1-, or 1½-in. thickness produces a satisfactory structure for certain castings that require density to resist air, water, or other pressure, it is well to have analyses made of the casting and duplicate mixtures for future work of that character.

To prove the importance of suitable mixtures for various sections, the author cast three wedge test-bars 16 in. long, 2 in. sq. at large end, tapered to a thickness of 3/16 in. Table I. gives the analyses of mixtures, and it will be noted that one is a straight grey-iron mixture and the other two semi-steel, containing 10 and 25 per cent. steel respectively.

TABLE I. *Analyses of Test Wedges.*

Wedge No.	Material.	Si.	Si	P	Mn.
1	Grey iron	2.50	0.116	0.70	0.50
2	10 per cent. semi-steel ..	2.25	0.110	0.53	0.53
3	25 per cent. semi-steel ..	3.00	0.085	0.40	1.05

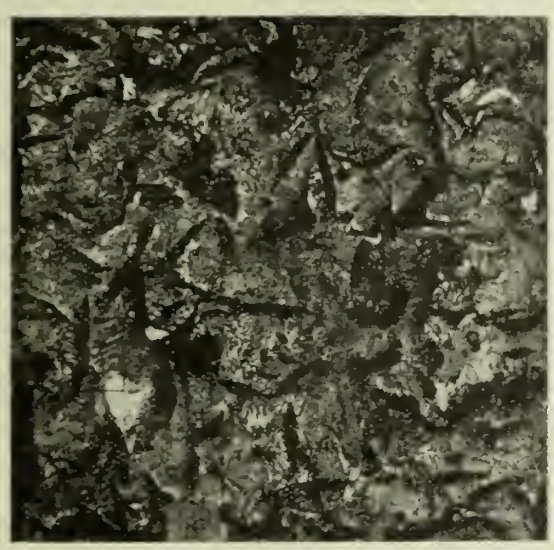
These wedges were examined under a high-powered microscope and microphotographs made of each at the largest end, 2 in. sq., and the thinnest section, approximately 3/16 in.

Micrograph No. 1 was taken from the 2-in. sq. end of cast-iron bar.

The massive black flakes are graphite; the black hair-lines or network are boundaries of white ferrite (pure iron) grains which form the main body or matrix. Here and there are islands of phosphide eutectic, which somewhat resemble a herring-bone structure.

Micrograph No. 2 was made from the same bar as No. 1 at the extreme end where the metal is as cast approximately 3/16 in. The magnification of No. 2 is the same as No. 1, but can one imagine it being of the same chemical analysis?

The light constituent is cementite with dark patches of pearlite. The metal was very hard and brittle; in fact, it was so hard that on the very thinnest edge it was partly chilled.



MICRO. No. 7 IS FROM THE THICK END OF WEDGE No. 3—*id est*, 25 PER CENT. SEMI-STEEL.

MICRO. No. 8 IS TAKEN FROM THE THIN END OF WEDGE No. 3.

Micrograph No. 3 was made from the same bar as No. 2 at the section where the white chilled part appeared to be mingling with the grey.

Micrograph No. 4 was taken from the 2-in. sq. end of the semi-steel, 10 per cent. steel, wedge. While the silicon and phosphorus are somewhat lower than in the grey-iron wedge, the black graphite carbon flakes are not so large and are surrounded by white ferrite, the latter bounded by a dark grey main body or matrix of pearlite. Here and there are small segregations of what appears to be manganese sulphide.

No. 5 is a thin section of the same bar as No. 4—the extreme light end of wedge.

The light constituent is cementite, combined carbon, Fe_3C. The dark constituent is pearlite.

No. 6 is of the same metal as Nos. 4 and 5, but at a point where metal was chilled and the white blends into the grey.

Light constituent is cementite; dark constituent is pearlite.

No. 7 is taken from the heavy end of semi-steel, 25 per cent. steel, wedge. Compare this with No. 1 and note the difference in size of black graphite carbon flakes. The light patches at boundaries of flakes are cementite not entirely broken up. The main body of dark grey is matrix of pearlite.

It must be understood that the author does not advise semi-steel of this analysis for castings 2 in. thick, but in carrying out the main idea of showing structure of metal at different sections, it was considered best to include semi-steel of 25 per cent. steel.

Microphotograph No. 8 was made from the same bar as No. 7 at the extreme furthest end, and metal is of the same analysis.

The light constituent is cementite; dark constituent is pearlite.

The semi-steel bar from which Nos. 7 and 8 were made is being used for small pistons which are about ⅝-in. thick when cast and 3 32-in. when machined.

Medium Phosphorus.

While it is well to aim for the very lowest phosphorus in certain mixtures, yet there are foundrymen who cannot follow this suggestion, owing to the lack of materials low in that element, and in that event it should be remembered that, due to the small amount of phosphorus in steel—0.02 to 0.06 per cent.—the more steel used the less phosphorus in the casting.

The founder should aim to use every pound of steel scrap in his mixtures that the section to be poured will carry, especially for castings which must stand hydraulic or other tests.

Assume the mixture required is 50 per cent. pig and 50 per cent. scrap, and the estimated analysis of phosphorus is 1.00 per cent. For every 5 per cent. steel added, take out 5 per cent. pig or return scrap, and this will reduce phosphorus 0.05 per cent., leaving 0.95 per cent. This is set out in Table II.:—

Per cent. steel in mixture.	Per cent. approximate phosphorus in mixture.
10	0.90
15	0.85
20	0.80
25	0.75
30	0.70
35	0.65
40	0.60
45	0.55
50	0.50

The total carbon in semi-steel is higher, and the silicon, sulphur, and phosphorus lower, that is, with the same melting condition, than if the same percentage of the best charcoal or cold-blast pig had been used instead of steel and with different melting conditions.

Steel breaks up the graphitic carbon flakes into granular form, because as the steel absorbs up to 5 per cent. carbon, a higher temperature is produced in the melting zone, and with the extremely high temperature and the metal being purer than grey iron, as it contains less silicon and phosphorus and more manganese, it is freed

from impurities or gases, which insures a close-grained metal leaving no interstices for large carbon flakes.

It is not the carbons alone that make semi-steel better and stronger than grey iron, but the lower silicon and phosphorus that may be used, section for section, therefore many engineers and machinists prefer semi-steel.

Heretofore, if grey-iron castings of ¼- to ⅜-in. section were to be cast, the founder would insist on high-phosphorus iron, but there are thousands of tons of semi-steel made every day for light castings, with 3/16- to ⅜-in. sections, with only 0.20 to 0.40 per cent. phosphorus, and practical foundrymen are frank in saying it is the hottest metal ever seen.

Of course, the high manganese partly offsets the lower silicon and phosphorus, and with a fair percentage of combined carbon, one would expect the metal to be duller in the ladle and harder in the castings.

Steel in its descent in cupola is absorbing carbon from coke, and immediately before reaching melting zone it contains so much carbon (up to 5 per cent.) that it is not steel of commerce but a high-carbon metal that mechanically increases its temperature even above that of the melting zone, which decreases its melting point. We claim most emphatically that when good melting conditions exist steel melts first.

Scientific Melting.

When steel is used in cupola mixtures the entire charging and melting conditions must be changed, especially the manner of lighting cupola and preparing it for charging.

Steel mixtures must be handled differently than iron, both before and after melting. The cupola should be hot, and care is required in charging; in fact, the author's slogan for years was: "Semi-steel must be mixed with brains," because the proper tuyere areas and blast pressures have much to do with the success or failure of it.

It has been stated, and the author believes it is a fact, that casting temperature is the secret of good semi-steel, for without the proper melting and pouring temperatures mixtures are not worth the paper they are written on.

Melting conditions in the steel foundry are approached at an entirely different angle from that of the iron foundry. In the steel foundry the melter in charge usually has many years' practical experience as a third and second hand, and must have a knowledge of furnace construction before given the opportunity to melt steel. But what a difference in the iron foundry!

The steel melter is told what percentage of elements is desired in his steel, and he calculates his charge accordingly. Later, as the heat progresses, he is guided by the actions and reactions taking place in furnace, and then decides what percentage of the deoxidisers (silicon, manganese, or other alloys) is necessary to produce steel within the specifications, but he never attempts to melt steel in a cold furnace.

What a difference the author found when he first began using steel in the iron foundry! Like the majority of foundrymen of those days, he thought he knew all about a cupola, although his foreman claimed to know a great deal more, but between them scant attention was given to the cupola operation. Why?

The cupola was there. It melted iron every heat and had done so for many years. Therefore the author believed the men in charge must understand the process, or, if they did not, the foreman would tell them. But did they? They knew how to melt iron, but the science of melting and the knowledge of cupola details was, and is, sadly lacking in many shops, even to-day.

High blast oxidises a large amount of manganese, silicon, and carbon. By lowering the total amount of carbon a higher percentage of combined carbon is obtained which increases the percentage of oxygen, nitrogen, and oxides—all of which have caused many to condemn semi-steel.

To make real semi-steel, one must be familiar with the fundamentals of scientific melting and the use of steel scrap in cupola mixtures.

High carbon is more essential than high silicon in thin sections for all metal tested to air or water pressure, hence the silicon may be carried much lower than is possible in like sections of grey-iron castings.

But how easy it is to make this assertion look absurd and untrue! The majority of foundrymen have never paid much attention to melting steel scrap in the cupola, and when doing so generally follow someone else's advice, who probably does not know any more about it than they.

They charge the steel in the cupola without a thought concerning its melting, that is, they do not pay attention to whether high or low blast is used. If high blast is used the resultant metal is condemned. It has been proved that while steel could be melted in any cupola, still the metal was not to be depended on, unless good melting conditions existed.

Annealed Semi-Steel.

Some years ago a concern using both steel and malleable castings desired to produce a more satisfactory metal for their product. This company manufactured a line of tools for the hardware and automobile trade. An investigation proved that neither the best malleable nor steel castings gave them the desired results, and our study of the treatment given both malleable iron and steel castings led the author to believe a more suitable metal could be made of annealed semi-steel.

Annealed semi-steel is preferable to either cupola or standard malleable iron for certain castings, as different percentages of steel may be used, depending on section and strength required. It may be hardened and tempered, and the tensile strength is considerably greater than the best malleable iron.

It is the author's belief that annealed semi-steel will supersede cupola malleable for castings more than ¼-in. thick, and even now several railroads are investigating its adaptability for castings over ½-in. section, as the tensile strength will run from 25 to 30 tons.

The cost of producing annealed semi-steel in comparison with malleable iron will depend on the tonnage melted per day, but we believe that, ton for ton, annealed semi-steel would cost less than the best malleable iron.

Annealed semi-steel is white when cast. It is annealed from three to seven days, depending on the sections, and recent experiments of heat treatments lead to the belief that quite a reduction of time will be experienced during the annealing period.

Foundrymen who lack sufficient confidence to make semi-steel instead of straight grey-iron mixtures will hardly be expected to believe that some of the castings made are cast of annealed semi-steel. This metal is made in the cupola, and is very good for wearing purposes, but, of course, will not stand shocks like alloy steels. Annealed semi-steel is very homogeneous, will twist or bend, may be hardened, will stand very high polish, and wears extremely well.

The Spearing Boiler Company, Limited, have been successful in securing the contract for two water-tube boilers, each of a normal evaporation of 52,650 lbs. per boiler, together with Ferguson superheaters, chain-grate mechanical stokers, and forced and induced-draught plant, for the Charing Cross, West End, & City Electricity Supply Company, Limited.

British Empire Steel Corporation.—In connection with the additions to be made to the plant of the British Empire Steel Corporation, Sydney, N.S., to cost $19,000,000, it is stated that the company's engineers are now preparing plans for new open hearths and a blooming mill which will cost about $10,000,000. One blast furnace is to be rebuilt and another extensively repaired, while a number of other additions and improvements will also be made to the plant. It is reported that the money to pay for these improvements is to come from a large loan to be made to the British Empire Steel Corporation by two large American financial houses, the negotiations for the loan being nearly completed. The company's business has been improving for the past three months, and everything points to continued improvement. The Company's pay-roll now amounts to $10,000 per day, this being the first time since November, 1920, that the pay-roll has reached this amount.

An Apprenticeship Course in Foundry Practice.—IV.

By Ben Shaw and James Edgar.

GREEN SAND, DRY SAND, AND LOAM MOULDING.

Moulding may be divided into three distinct classes—green sand, dry sand, and loam moulding. Each class has its own particular characteristics, which depend, to a certain extent, upon the condition of the sand when used, and also upon the time necessary for its preparation to receive the molten metal. Any one of these different classes, or two in combination, are employed in the formation of moulds necessary for the wide variety of castings produced.

The moulder generally specialises in one of these particular classes of moulding, but an apprentice should have facilities for actual experience in each branch in order to assist in determining that for which he is best suited. Unfortunately, all foundries have not the facilities, and in many where they are available the apprentices are not given the opportunity to familiarise themselves by actual practice with any form of moulding apart from that which they commence at the bench or on the floor. No moulder is capable of undertaking the duties of a foreman, particularly in a general foundry, unless he is quite familiar with the operations involved in all the branches of moulding, and while actual practice is not absolutely essential to this end, it is, nevertheless, of the utmost value.

Some foundries make a speciality of green-sand moulding to the exclusion of other classes, some do not make any moulds in green sand, all the work, apart from tackle used in the making of a mould, being done in dry sand, or dry sand and loam, while in others, known as general or jobbing foundries, the work embraces all the different classes of moulding. It is imperative for an apprentice who wishes to become an efficient moulder to get a knowledge of the principles and methods of all the processes. In all foundries where only the green-sand process is employed, an apprentice may be handicapped, but it is still possible for him to take an intelligent interest in loam work, which may open the way to an opportunity for practical experience later on, and enable him in after years to take charge of a foundry where loam and dry sand, as well as green sand, are used.

Green-Sand Moulding.

In a lecture delivered last year by Dr. Alexander Scott, M.A., the following statement was made:—"When one came to deal with the fine grained materials which were present in sand, and which, for convenience, one would call bonding material, it would be found that the grains were not clean, but were surrounded by a very thin pellicle of some other material. In some cases this was clay, sometimes it was quartz, sometimes limonite, sometimes glauconite, and sometimes ferric oxide. In the Aylesbury sand it was a peculiar green silicate of iron and potassium, hence the name "green sand." This is a technical explanation of the term green sand, but for practical purposes it is sufficient to regard the expression green sand as applied to a form of moulding for a similar reason to that which is implied when green timber is spoken of. It means that the sand contains its natural moisture, or has sufficient water added to it to render it workable, and moulds prepared from it receive the molten metal while it is still in a damp condition. It is a weak sand, low in clayey matter or bond, and it is not capable of retaining the form given to it when the moisture has evaporated, hence while it depends upon the moisture for giving the amount of plasticity, without which the desired impression could not be made, it is equally as essential at the time of casting to give the sand strength to resist the rush and pressure of the metal. A sand-mixture, strong in bond, cannot be used satisfactorily for green-sand moulding, the additional clayey matter and the moisture reducing the pore space between the sand grains, which prevents the metal lying against the moulds so constituted, causing them to "blow," the steam and gases generated at the time of casting not being able to escape through the sand quickly enough.

This class of moulding is employed in a more or less degree, for all metals and alloys common to the foundry, although it is necessary to grade the fineness and composition of the sand according to the metal for which it is to be used. As a rule green-sand moulds consist of two kinds of sand, the ordinary floor, or backing sand, which has been in use and lost to a certain extent its cohesive power, and facing sand, which is really that with which the metal comes into contact. This facing sand is specially prepared according to the character of the work to be done, and the metal to be cast against it. While all sand-mixtures used in green-sand moulding are weak compared with those used in other classes of moulding, there are different degrees of strength, and generally a stronger-bonded sand can be used for castings having comparatively heavy sections than is possible with light work. The facing sand for moulds to receive cast iron contains a percentage of coal-dust, and this mixture is frequently referred to as a strong or weak facing sand, according to the amount of coal-dust it contains without reference to its bonding qualities. A weak facing sand implies that the percentage of coal-dust is low, a condition which is desirable for castings of light section. Other ingredients may be introduced instead of coal-dust, such as finely ground coke and charcoal or blacking, but coal-dust is comparatively cheap and quite as effective for this purpose.

Coal-Dust.

Coal-dust is really added to protect the face of the mould, thus ensuring a better skin on the casting, and although it is frequently referred to as a means of increasing the porosity of the sand under the heat of the metal, its value in producing a better skin on the casting is a more important consideration. The heat of the metal generates a gas from the coal-dust which forms a thin protective cloud about the face of the mould, preventing the direct contact of the metal with the sand surface. This is responsible for the comparatively clean skin produced on the castings. The difference in quality of surface produced on iron castings can easily be seen by using facings with and without coal-dust. When it is not used the metal has direct contact with the sand and at the high temperature it acts upon the impurities in the mixture, and fluxes, caused by small particles of slag, adhere to the metal surface. The surface of the castings is therefore roughened, and not comparable with that produced when the facing contains coal-dust. Partly for reasons of economy, and the fact that too much coal-dust would be injurious, the percentage is graded to suit the thickness of metal, varying from one of coal-dust to seventeen of sand for light work to one in eight for castings of heavy sections. Only that amount is required which will maintain the film of gas until the casting has solidified. Coal-dust is not used as an admixture for green sand moulds which are to receive molten steel, because the gas formed would not withstand the higher temperature and would, therefore, be of no value as a protection for the sand. The facing mixtures must be particularly free from impurities for this class of work, and flour silica, together with graphite, may be dusted over the moulds and sleeked where possible, as an additional protection against impurities.

The facing sands used for brasses and bronzes frequently contain coal-dust, particularly when the moulds are to be skin dried, but for ordinary green-sand moulds the admixture can be neglected in favour of a dusting of pease-meal, or a mixture of pease-meal and French chalk.

While reference has been made to skin-dried moulds, it must be distinctly understood that those are different from dry-sand moulds. The purpose of skin drying green-sand moulds is to obtain a skin on the casting which more nearly approxi-

mates to that produced in dry-sand moulds without the loss of time involved in complete drying.

The actual mixtures used for facings cannot be given satisfactorily in this article, as they depend largely upon the character of the new sand and the work for which they are to be used. The proportion of new sand to old sand is smaller for light work than for heavy work, but the amount depends upon the clayey content of the new sand. It is important that the moisture content should be low with all green-sand facings. An excess of moisture would hinder the metal from lying quietly against the mould and cause it to blow. The increased quantity of steam generated, and the decreased pore space, due to the excess of moisture, result in the fluid metal offering the least resistance to the escape of the steam. This is a frequent cause of water castings.

The quantity of moisture desirable is frequently considered as a percentage of the whole, thus from 5 to 7 per cent. of moisture is generally accepted as a convenient quantity. This method of computation is quite satisfactory when the facing is prepared in a mixer and both old and new sand are added dry; then the requisite amount of water can be added. This is a practice which is often resorted to for green-sand work in steel foundries, but when the sands to be mixed contain moisture the percentage method is not a very convenient one. Experience is of great assistance in determining whether the facing sand contains about the right quantity of moisture. The simple method of squeezing a quantity of sand with the hand is frequently used to determine its condition with regard to moisture and also plasticity. When the hand is opened the sand should maintain the shape given to it, and leave the hand quite clean, if sand adheres to the fingers it is too damp, and if the shape breaks up into a number of pieces, is loose or friable, then it is not damp enough. Facing-sands are best prepared in a mixer, in order that the composition may be regular, but in many jobbing foundries, when almost every job requires a special mixture, the moulder is responsible for his own facing sand, and it is then mixed by hand with the necessary amount of coal-dust added to suit the particular work.

The most important advantage possessed by moulding in green sand is its relative cheapness combined with rapidity of production. Metal can be cast directly the moulds are completed, assembled and clamped, and there is the further advantage that tackle and equipment can be used more than once in the same day.

Dry-Sand Moulding.

In this class of moulding the sand is used in a somewhat similar condition to that suitable for green-sand moulds, but it is dried preparatory to receiving the molten metal. It is a strong sand containing more clayey matter than green sand in order that moulds prepared from it will have stability when dried. The increase in the proportion of clay closes the texture of the sand and reduces its permeability, and for this reason all moisture must be removed not only to reduce the amount of gas generated, but to open the pores of the sand. A damp sand is less permeable than a dry sand, other things being equal, because much of the pore space is occupied by the moisture. The difference in the strength of the sands used is a most important distinction between green-sand and dry-sand moulding. The former is open in texture and is weak in bond, and the moisture is essential to give it body or strength, otherwise it would crumble and collapse before the molten metal, whereas strong sands are close in texture and must have all moisture driven from them so that gases generated at the time of casting will escape more readily without injuring the surface of the metal. Backing sand, which is floor sand and facing sand combined, is also used in the making of moulds to be dried, and it must be distinctly understood that the floor sand is distinct from that which is used for green-sand moulding, being limited to that sand which has previously been used for dry-sand moulds. Coal-dust is not added to the facing mixture, but a protective coating is applied to the surface of the mould after it has been dried, which answers the same purpose, and indeed, gives a better face on the casting.

It is of little value giving representative mixtures for facing sands suitable for dry-sand moulds. The character of the work to be done, the kind of metal to be cast, and the composition of the moulding sand at hand, are the factors which determine the mixture. Practical experience is essential to maintain regular quality of facing sand from day to day for similar classes of work. Those for cast iron frequently contain a considerable quantity of loam which has been previously used, and a quantity of new sand in the mixture can then be reduced. When loam is not available, old sand is mixed with new in varying proportions according to its strength.

Some sands are very weak, while others are very strong. With the former only available as a new sand it is advisable to maintain a supply of clay to maintain the requisite strength. It is better to dry and pulverise the clay before introducing it to the mixture, or as an alternative, the requisite amount may be mixed with the water which is used to temper the mixture of sand. When the mixture is considered to be too strong, sharp sand or sea sand may be introduced to lower its clayey percentage and open the texture; in some cases coal-dust is used for the same purpose. These mixtures are preferably milled in order to toughen as well as thoroughly mix them. Considerable care is necessary in the milling, as it is possible to render the sand lifeless by too much milling. About ten minutes milling for a coarse facing such as would be required for a large job, and about twenty minutes for a fine facing sand is about the average amount of milling suitable for extreme grades. This is, of course, only a rough guide, as there are different forms of sand mills, having rollers of different weight, which revolve at varying speeds, but it is sufficient to draw attention to the fact that facing sand can be overmilled. Prepared facings should be passed through a disintegrator after milling in order to aerate it, though many foundries are content with passing it through a mechanical riddle before leaving the mill.

Facing mixtures used for cast iron suffice as a rule for moulds to receive brass or bronze. This does not mean that the same mixture should be used for both iron and brass, but mixtures having a similar degree of refractoriness, permeability and strength. More refractory facing sands are necessary for moulds to receive steel involving the use of a purer sand. For light and medium sized work, sand which has previously been used is milled with new sand according to the strength required. Pulverised china clay is frequently used to increase strength when desirable, because of its freedom from impurities. Many prefer to have a washed sand, that is, sand from which the clayey matter has been removed, and to this is added a quantity of new sand and the requisite amount of clay. It is important to remove the fine earthy matter into which the clay is converted under the heat of the metal from the used sand. For heavier work "compo" which has been previously used, together with a certain amount of new sand is milled to provide the facings.

Dry-sand moulds are adopted in preference to green sand, when the additional cost of preparation and drying is compensated by a reduction of bad castings, such as might be expected if green sand is used. Greater risk is attached to the making of sound castings in green sand, and the degree of risk is increased in proportion to the size and intricacy of the casting to be made. Though a better defined shape is obtained in green sand, the surface produced in the castings is inferior to that on dry sand work.

Loam Moulding.

This class of moulding differs considerably from those previously described. Though the mould surface, when completed, is similar to that of a dry-sand mould, the condition of the sand or loam when used, the method of application, and the construction of moulds are very different. The loam has a consistency resembling that of plaster, it being used stiff or thinned with water as circumstances warrant. Bricks are involved in the building of loam moulds, and cast-iron plates introduced to support them and to give facilities for lifting. The moulds, when completed, are dry

and the surface with which the metal has to come into contact are blackwashed in a similar manner to dry-sand moulds. The mixtures of sand used are not unlike those used for dry sand work, but as a rule they are stronger. While there are many mixtures known by many names common to the foundry or districts in which they are used, they are generally divided into three classes, common or building loam, facing loam, and core loam. The common loam compares with the floor or backing sand in dry sand work, and is used in the same manner as cement, that is between bricks when building a mould, the surface of the mould to receive the metal consisting of facing loam which is finer. Owing to the greater strength of these mixtures, it is necessary to introduce openers in order that the moulds will be sufficiently porous at the time of casting. For this purpose chopped straw, horse-dung and cow hair are commonly used. Many founders reduce the strength with ground coke, or sharp sand may be added until the facing loam has the required strength.

Strong facings crack considerably on drying, and great care has to be exercised in filling to avoid corresponding marks on the castings.

Core Loam.

Core loam is prepared in a similar manner, but special mixtures are required which will be sufficiently loose and friable, after the metal has been cast, to be readily removed from the cooled casting. As a strong loam bakes very hard, and, apart from the resistance offered to the casting during the time of cooling, is most difficult to remove from the casting when cleaning, it should, therefore, be reduced in strength, and for this purpose chopped straw and also sawdust may be added. Sometimes common blacking is also added, and this helps to disintegrate the loam after the metal has been cast.

Moulding in loam is limited to medium and large sized work simply because it has little economical value for small work. Owing to the fact that a pattern can be wholly, or to a very great extent, dispensed with, it is a method much used for the production of cylindrical castings. A sweeping board having a profiled edge similar to the cylindrical shape desired can be used, and those parts which cannot be swept are made of loam, and either introduced into their respective positions during the time of sweeping, or attached after the shape has been struck up. The mould required may be swept to shape, or a loam pattern may be prepared, which, when dried can be used to provide a mould in sand or loam.

Full patterns, that is patterns having a solid exterior, are not suitable for loam work though many are used. The wood absorbs a considerable quantity of moisture from the loam and causes it to swell. This frequently alters the important dimension of the pattern. Another disadvantage of the full pattern is encountered when stripping; it is necessary to stove the mould before the pattern is withdrawn and resinous matter from the wood is absorbed by the loam causing it to stick or weakening the face of the mould, which may cause it to scale when it receives the metal. When patterns are necessary, the wood-work on them should be limited, frame skeleton, or what might be termed skeleton shell patterns, being most suitable.

The choice of loam, dry sand, or green sand, depends largely on the general practice of the foundry, the design of the work, and also, as has been already stated, by its size. Some foundries make a speciality of loam work, while others only use loam for moulds when the pattern work supplied leaves no option.

Of the three classes, loam moulding gives the greatest scope to the moulder. He must possess initiative and ingenuity in deciding upon an economical method of construction suitable to the work in hand, and also in devising suitable tackle. The capacity for reading drawings is of greater value to the loam moulder than either the green or dry-sand moulder, because, as the pattern work is as a rule limited, he must be guided by the drawing. In each class, however, there is ample room for the development of the highest skill, not only in the manipulation of the sand or loam, but in devising the construction of moulds to the best advantage.

New Suggestions for Notched-Bar Tests.

In a recent issue of "Stahl und Eisen," Dr. Strinbeck discusses the question of shock tests on notched bars. While not denying their importance in acceptance tests, he advises greater caution in accepting the results of such tests without a more thorough investigation of the principles on which they are based. He bases his opinions on a series of tests which he has carried out and on the tests of other workers. Whereas when judging materials with regard to the specific purpose for which they are intended, it may be sufficient to do so from the point of view of their physical suitability, i.e., their structure, in practice, notched-bar tests must proceed from the basis of the materials as technically prepared in the workshop for specific purposes. This is, of course, in addition to securing uniformity in the shape and size of test-pieces. Taking the case of the tests carried out on boiler-plates, the author points out that the German regulations of 1907 state that the rolled surfaces of the plates form the lateral margins of the notched test-pieces. The width of the cross-section of the bar is therefore equal to the thickness of the plate. The reduction in cross-section due to the notch has always to be 15 mm. (0.6 in.) high. The test bars of plates of different thicknesses have therefore different widths where the height is the same.

Tests by various authorities, however, have shown that, where the test-pieces exceed a certain width, the specific work of impact falls off sharply and exhibits irregularities. By means of a curve the author shows that the specific work of impact decreases with increasing width of test-piece, this decrease not being regular or steady, but giving rise to a gap in the curve which the author calls a "zone of aberration." This zone depends in height, width and position, on the chemical composition of the iron and steel, and on the mechanical and heat treatment to which it is subjected. The result is that the consumer sometimes rejects plates as unsatisfactory in quality, which are really quite good. The practice, therefore, of making the width of the test-piece equal to the thickness of the plate, and the height of the dangerous cross-section invariable, is untenable. In place of this the author suggests (1) that the thickness of the plate should be regarded as the width of the test-piece, the height of the test-piece being fixed at a proper ratio to the former. This, however, would give very small cross-sections for a plate only 5 mm. thick. (2) It would be better to make the notch starting from the roller surface of the plate so as to fix the width of the bar. In the former case the cross-section would have to be defined for various thicknesses of plate, while in the second case both the width and height would have to be so defined.

The use of the round notch only for small test-pieces of 8-10 cm. (say 3 in. to 4 in.) the author regards as likely to impair the efficiency of the notched-bar test. Only by using a sharp, angular notch is the test rendered valuable as an acceptance test for materials having a high notch tenacity. The notched-bar test must not, however, be regarded as satisfactory for all classes of iron and steel. It ought not indeed to be prescribed at all for materials of low notch tenacity.

The dependence of notch tenacity on the rate of impact is another matter requiring careful consideration, the German authorities having considered that in the Charpy test the effect of the velocity of impact is negligible. The author argues against this view, urging the possibility that certain materials may have a "zone of aberration" (as already noted) in the sense that the work of impact within certain limits of velocity may be sometimes high and sometimes low, according to the zone of aberration, which itself depends on the width of the test-piece. In judging of materials from their notch tenacity, their behaviour at very high velocities should also be studied. Only those materials should be included which exhibit a high degree of notch tenacity even at very high "striking velocities." As "rate of impact" is not synonymous with "velocity at impact," the velocity of the tup after breaking through the test-piece should be considered.

The Development and Manufacture of High-Tenacity Brass and Bronze.*

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from page* 80.)

Aluminium Manganese Brasses.

For the purpose of this investigation the ternary alloys A1, A2, A3 and A4 were taken as basis, the Mn. additions replacing the Zn.

Manufacture.—Constant conditions were maintained throughout, and were those adopted in the ternary series. Mn. does not improve the casting qualities, and unless great care is taken, overlaps and surface unevennesses are formed owing to the ready oxidation in the molten state. No difficulties were encountered in forging, rolling, extruding or cold drawing. Owing to the polymorphic nature of the "Alpha-Beta" series, higher temperatures than 750 deg. C. and rapid cooling after working should be avoided, otherwise they will possess the properties of an all "Beta" brass. When hardened or embrittled by such treatment arnealing at 650 to 700 deg. C. is recommended, and cooling to 500 deg. C. during a period of at least one hour.

Effect of Manganese on 1 per cent. Aluminium Brasses.

Alloy AM5, Table VIII., shows the effect of 3.5 per cent. Mn. on alloy A1, retaining the Cu. content constant at 59 per cent. In the cast condition the yield point, maximum stress and hardness are practically unchanged, but the ductility as measured by both static and dynamic stress tests is lowered. Forging reverses this state of affairs, the manganese alloy being superior in both tenacity and ductility, although each offers a good range of mechanical properties.

Fig. 11 illustrates the micro-structure of AM5 in the "cast" condition, and shows Mn. to reduce the size of the crystal grains, to break down the junctions of adjacent grains, and to increase the quantity of the "Alpha" constituent. This latter feature corroborates the author's previous finding that Mn. is a Cu.- rather than a Zn.-replacing element. In view of the observed structural change, the natural corollary is that Mn. is beneficial to the ductility and toughness of Al. brass castings, yet actually, the reverse proved to be the case.

The explanation of this is clear from Fig. 12, which shows films of a brittle Mn.-rich constituent to have formed at the junctions of the adjacent crystal grains. The advantage, therefore, of the refined texture does not appreciate until this undesirable structural weakness has been eliminated. Fig. 13 shows the effect of forging in this direction, and to have conferred to the forging a grain which strengthens against stress applied at right angles to the grain, but weakens it against stress applied parallel with it.

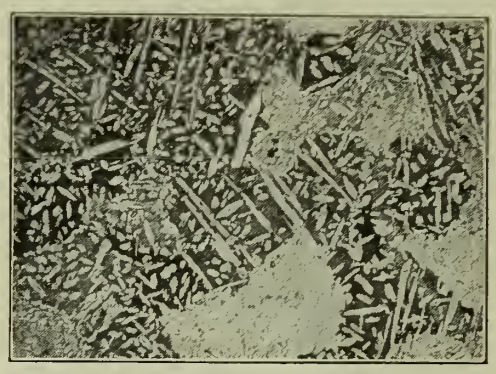


Fig. 11, showing Microstructure of Alloy AM5 "As Cast."

TABLE VIII.—*Showing the effect of* 3.5 *per cent. Mn. on alloy* A1.

Mark.	Composition. Cu.	Zn.	Al.	Mn.	P.	Fe.	Physical Condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per cent. on 2 in.	R. A. Per cent.
A.1.	59.48	39.55	1.00	Nil	Nil.	Nil.	As cast ..	14.80	32.00	30.00	33.50
							As forged ..	11.10	31.30	41.00	44.60
AM.5.	59.45	35.85	0.98	3.49	0.01	0.22	As cast ..	13.40	31.80	25.00	24.60
							As forged ..	20.70	35.10	36.00	47.20
A.2.	58.35	40.11	1.54	Nil.	Nil.	Nil.	As cast ..	16.40	35.20	17.00	18.50
							As forged ..	11.60	36.40	28.00	34.00
AM.2.	59.45	36.60	1.56	1.97	0.02	0.40	As cast ..	17.00	35.90	22.00	20.00
							As forged ..	17.20	37.00	28.00	30.60

TABLE VIII.—continued.

Mark.	Tensile Fracture.	Alternating impact No.	Fracture.	Brinell hardness No.	Sclero-scope hardness No.	Crysta grains per sq. cm
A.1.	Coarse, stony, accicular. Trace of inter-crystallinity along the 2 in. parallel.	46	Fine, stony	114	21	αβ
	Fine, stony, free from inter-crystallinity	67	Fine, stony, semi-vitreous ..	104	18	αβ
AM.5.	Fine, granular, short. Extension uniform over the 2 in. parallel.	18	Fine, stony, crystalline ..	114	21	αβ
	Stony, granular, cup and cone, silky edges.. ..	75	Fine, stony, silky	134	23	αβ
A.2	Between A.1 and No. 6, in appearance	23	Coarse, crystalline, stony ..	129	21	αβ
	Crystalline	41	Coarse, crystalline, stony ..	138	22	αβ
AM 2.	Highly crystalline, very pale yellow, free from lustre. Trace of inter-crystallinity along 2 in. parallel.	27	Short, fine, crystalline, with a slight lustre.	138	26	143
	.. ..	41	Fine, stony, granular. Trace of inter-crystallinity.	148	33	170

Effect of Manganese on 1½ per cent. Aluminium Brasses

The test results in the "As Cast" and in the "Forged" conditions are included in Table VIII., alloy AM2. The Mn. additions are limited to 2 per cent., no object being served by exceeding

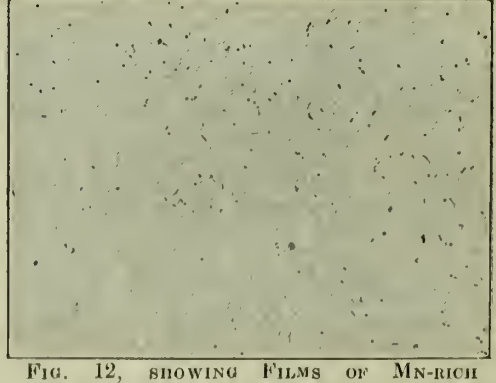


Fig. 12, showing Films of Mn-rich Constituent at Junctions of Crystal Grains.

this amount. The tensile and impact tests suggest Mn. to slightly improve the ductility. Apart from this, its influence is apparently negligible in either the cast or forged state.

Micro-structure.—Manganese shifting the position of the "Beta" phase field-boundary to the right, the micro-structure is changed from an all

Fig. 13, showing the Effect of Forging.

"Beta" brass to an "Alpha-Beta" brass. This does not imply the mechanical properties of alloy A1. or allow AM5—both of which contain 40 to 50 per cent. of the "Alpha" phase—as the predominating micro-constituent determines the final physical properties.

The structural change wrought by the addition of 2 per cent. manganese on alloy A2 is shown in Fig. 14, although this alloy contains 1 per cent. of Fe. in addition to 2 per cent. Mn.

Mn. appears to reduce the shock-resisting properties in the "cast" state, and 2 per cent. Mn. to increase the yield point, maximum stress and hardness without affecting the ductility. Reducing the Cu. content of the latter alloy to 57 per cent. and proportionately increasing the Zn. content (alloy AM3D), apparently lowers the yield point without affecting the tenacity and hardness, but

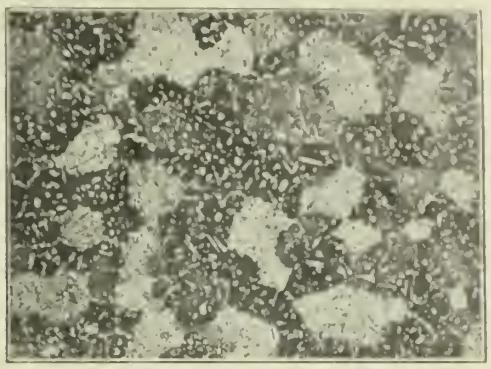


Fig. 14, showing the Influence of 2 per cent. Manganese on Alloy A2.

improves the ductility as measured by both the tensile and impact tests.

Reverting to the 3 per cent. Al.-59 per cent. Cu. basis brass, 4 per cent. Mn. (alloy AM13) raises the yield point maximum stress and hardness, but adversely influences the ductility. The improvement made by forging, demonstrates the value of Mn. in these alloys in the forged, stamped, rolled of extruded conditions.

Micro-structure.—Each alloy was found to pos-

TABLE IX.—*Showing the Effect of Manganese on Aluminium Brass.*

Mark.	Composition. Cu.	Zn.	Al.	Mn.	Pb.	Fe.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per cent. on 2 in.	R. A. per cent.
A.3.	58.26	38.56	2.18	Nil.	Nil.	Nil.	As cast ..	16.00	36.40	16.00	21.50
							As forged ..	13.00	38.90	22.00	30.00
AM.4.	58.15	35.18	2.24	4.10	0.08	0.25	As cast ..	23.90	40.50	14.00	15.00
							As forged ..	24.80	43.40	18.50	21.50
AM.2B	57.23	37.90	2.59	2.08	Nil.	0.20	As cast ..	19.40	41.40	18.00	20.00
							As forged ..	20.50	42.60	24.00	24.50

TABLE IX.—continued.

Mark.	Fracture.	Alternating impact No.	Fracture.	Brinell hardness No.	Sclerescope hardness No.	Crystal grains per sq. cm.
A.3.	Coarse, crystalline	25	Coarse, crystaline, stony ..	138	22	202β
	Crystaline	39	Coarse, crystaline, stony ..	143	23	149β
	Whitish yellow colour. Coarsely crystalline. Free from lustre. Inter-crystalline along the 2 in. parallel.	15	Whitish grey. Coarsely crystalline.	165	—	192 β
A.M.4.	Whitish yellow colour. Oblique, hackly. Marked crystalline. Free from inter-crystallinity along the 2 in. parallel.	39	Whitish grey. Fine crystalline.	159	—	3.700 β
A.M.2B	Fine, crystalline	20	Stony, strongly crystalline at outer edges.	165	25	387
	Oblique, even, crystalline, high lustre	29	Fine crystalline, stony. Presence of trace of a larger crystalline structure due to incipient overheating.	159	28	467

Effect of Mn. on 2, 2.5 and 3 per cent. Al. Brasses.

By a further addition of 1.0 per cent. Al. to the 1 per cent. Al.-4 per cent. Mn., alloy (AM5), the yield point and maximum stress are appreciably increased, but at the expense of the ductility as in alloy AM4 in Table IX. By raising the Al. to 2.5 per cent., reducing the Mn. to 2.0 per cent. and the Cu. to 57 per cent. (alloy AM 2B, Table IX.), the test results are very similar to those obtained from alloy AM4, excepting that the yield point is lower.

In view of the interesting test results obtained from the 3 per cent.. Al. brass (alloy A4, Table II.) a series of alloys of this type was prepared, and a new standard marked No. 6—Table X. To the first, 1 per cent. Mn. was added, to the second 2 per cent. Mn., to the third 4 per cent. Mn., retaining the Cu. and Al. constant at 59 per cent. and 3 per cent. respectively.

Complete data regarding composition and test results are given in Table X. Here 1.0 per cent. sess in all "Beta" structure. The Mn.-rich constituent formed in alloys AM4, AM2B, AM3C, AM3D and AM13, is responsible for the embrittlement in the "cast" state and a reduction in the size of the crystal grains. A notable structural feature of Mn.-Al. "Beta" brasses is the interpenetration of the adjacent grains, and the evidence of a more mixed orientation. This is particularly well-displayed by the fracture. Generally speaking Cu. Zn. "Beta" brasses and Al. "Beta" brasses present a coarse crystalline fracture with bright crystal facets, whilst Al. Mn. "Beta" brasses invariably exhibit a mixed granular and crystalline fracture, and the crystal facets lack lustre and have a stony appearance.

Aluminium-Manganese-Iron Brasses.

The principal high-tenacity brasses of to-day contain Al., Mn., and Fe. They vary widely in composition, but generally fall within the following limits:—Cu., 57 to 64; Zn., 31 to 40; Al., 0.20 to

4.0; Mn., 1.0 to 4.0; Fe, 0.10 to 2.0; and Sn., nil to 1.0. Although alloys are made which do not come within this range, some of which contain as many as 15 elements.

refining the texture, its value, if any, must be that of a toughener.

Alloy AM6, in Table XI., shows the effect of 1.0 per cent. Fe. on alloy AM2—the Fe. meant to

Table X.

Mark.	Actual composition. Cu.	Zn.	Al.	Mn.	P.	Fe.	Physical condition.	YP. Tons per sq. in.	MS. Tons per sq. in.	E. Per cent. on 2 in.	RA. Per cent.
6	58.85	38.05	3.10	Nil.	Nil.	Nil.	As cast	20.50	38.60	19.00	21.50
							As forged ..	18.90	43.00	29.00	33.50
AM.12	58.87	37.13	2.94	0.96	Nil.	0.10	As cast ..	20.80	38.70	11.00	11.80
							As forged ..	20.50	40.80	22.00	24.50
AM.3C	59.34	35.34	3.10	2.02	Nil.	0.20	As cast ..	23.70	43.00	15.00	15.00
							As forged ..	23.60	43.40	19.00	24.50
AM.3D	57.07	37.68	3.12	1.81	Nil.	0.32	As cast ..	19.80	43.90	20.00	21.50
							As forged ..	20.70	44.90	33.00	44.60
AM.13.	58.32	34.54	3.12	3.92	Nil.	0.10	As cast ..	22.80	45.30	13.00	20.00
							As forged ..	24.50	43.80	22.00	27.60

Table X.—continued.

Mark	Tensile Fracture.	Alternating impact No.	Fracture.	Brinell hardness. No.	Sclero-scope hardness. No.	Crystal grains per sq. cm.
6	Coarse, crystalline, deep reddish colour	30	Coarse crystalline, reddish colour	148	—	152
	Flaky, coarse, crystalline, deep reddish colour ..	49	Fine, crystalline, reddish colour.	159	—	2,555
AM.12	Coarse, crystalline. as No. 6 but not quite so lustrous.	9	As No. 6, but not quite so lustrous.	159	—	—
	Fine, reddish, granular, flaky	29	Fine, reddish, mixed, crystalline and granular.	159	—	—
AM.3C	Coarse, crystalline, stony, with a slight lustre. Trace of inter-crystallinity.	23	Stony. Crystalline at outer edges.	171	27	125
	Between AM.1 "Forged" and AM2B. "Forged" in in appearance, and is free from inter-crystallinity along the 2 in. parallel	39	As AM.2B. "Forged." ..	165	30	62
AM.3D	Coarse, crystalline and much inter-crystallinity ..	23	Fine, crystalline, exhibiting inter-crystallinity.	154	—	760
	Fine, red fracture, free from inter-crystallinity ..	93	Fine, amorphous, indicating "Forging" too cold.	165	—	3200
AM.13	Mixed fracture, mainly earthy, what crystallinity is present is free from lustre.	14	Fine, whitish, earthy, with a tinge of crystallinity.	171	—	—
	Fine, earthy, granular, laminated, rough ..	70	Fine, whitish, earthy, granular	171	—	—

TABLE XI.—*Showing the effect of* 1 *per cent. Fe. on alloy AM2.*

Mark.	Actual composition. Cu.	Zn.	Al.	Mn.	P.	Fe.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per Cent. on 2 in.	R. A. Per Cent.
AM.2	59.45	36.60	1.56	1.97	0.02	0.40	As cast ..	17.00	35.90	22.00	20.00
							As forged ..	17.20	37.00	28.00	30.60
AM 6	58.74	36.61	1.60	1.83	Nil.	1.22	As cast ..	17.90	36.50	19.00	21.50
							As forged ..	17.80	36.90	34.00	46.00
AM.11	58.76	35.16	1.95	3.43	Nil.	0.20	As cast ..	22.00	39.60	13.00	18.30
							As forged ..	21.00	40.70	17.00	21.50
AM.14	58.11	34.31	1.95	3.98	Nil.	1.65	As cast ..	21.10	42.30	14.00	18.30
							As forged ..	19.90	39.50	28.00	33.50
AM.3C	59.34	35.34	3.10	2.02	Nil.	0.20	As cast ..	23.70	43.00	15.00	15.00
							As forged ..	23.60	43.40	19.00	24.50
AM 3B	59.67	32.73	3.30	2.05	0.27 (Silicon)	2.25	As cast ..	25.00	43.70	13.50	18.30
							As forged ..	24.70	44.00	27.00	33.50

TABLE XI.—continued.

Mark.	Tensile Fracture.	Alternating impact No.	Tensile Fracture.	Brinell hardness No.	Sclerescope hardness No.	Crysta grains per sq. cm.
AM.2	Highly crystalline, very pale yellow, free from lustre. Trace of inter-crystallinity along 2 in. parallel.	27	Short, fine, crystalline, with a slight lustre.	138	26	143
	.. ..	41	Fine, stony, granular. Trace of inter-crystallinity.	148	33	170
AM.6	Fine, earthy, semi-cup and cone	33	Fine, crystalline	129	21	3,937
	Fine, earthy, semi-cup and cone	46	Fine, crystalline	138	22	4,500
AM.11	Coarsely crystalline. Whitish grey. Free from lustre.	20	Fine, stony, almost free from crystallinity.	159	—	239
	Oblique, shear-like appearance	44	Fine, stony, free from crystallinity.	159	—	187
AM.14	Fine, crystalline, whitish grey, almost earthy ..	17	Short, fine, earthy	165	—	6,365
	Fine, yellow, earthy, granular, silky edges ..	41	Fine, earthy	159	—	14,215
AM 30	Coarse, crystalline, stony, with a slight lustre. Trace of inter-crystallinity.	23	Stony, crystalline at outer edges.	171	27	125
	Between AM.1 forged and AM.2.B forged in appearance, and is free from inter-crystallinity along the 2 in. parallel.	39	As AM.2.B forged	165	30	62
AM 3B	Dull yellow, spongy appearance, shallow semi-cup and cone, silky edges.	17	Fine, crystalline, dull ..	171	31	5,824
	Granular, semi-cup and cone. Trace of silky edges.	43	Fine, crystalline, pale brown, free from lustre.	178	31	11,020

That Fe. cannot be regarded in the light of a hardener or strengthener in this class of alloy has been established by the iron-brass series. Acting as a Cu.- rather than a Zn.-replacing element, and replace 1.0 per cent. Zn. In the chill cast condition, the tensile and hardness figures remain unchanged, although the toughness is somewhat improved. The change in this direction is by no

means proportional to the corresponding reduction in the size of the grain, the full advantage of which does not appear to materialise until the cast structure has been broken down by mechanical work.

Fig. 14 shows the micro-structure of alloy AM6 and illustrates the structural changes wrought in alloy A2 by the substitution of 3.0 per cent. of Zn. by 2.0 per cent. Mn. and 1 per cent. Fe.

Alloy AM14 serves to demonstrate the effect of 1½ per cent. Fe. on alloy AM11. Here, again, the grain refining effect of Fe. does not improve the mechanical properties until after forging. Alloy AM3B exhibits identical features and special comment is not necessary, the test results and details of the fractures being self-explanatory.

Before concluding this section, attention should be drawn to the yield point figures given in this Paper, which appear in some instances to be both erratic and contradictory. In considering the elastic properties of brass, however, it must be remembered that there is no uniform relation between the proportional limit and the yield point, and that from the ordinary extensometer diagram it is difficult to locate where the elastic state ends and the plastic state begins, or even make a satisfactory comparison of the form of the curves of one alloy with that of another. The yield point figures given indicate the stress to produce a permanent set of 0.01 in. on a 2-in. gauge length, and nothing more. They are included in this Paper because of their common insertion by the engineer in his specification, although some form of dynamic stress test would better serve his purpose.

Heat Treatment.

From the comments made on the microstructure of these brasses, it is evident that high strength brasses may be divided into three categories, "alpha," "alpha beta," and "beta," according to the predominating micro-constituent.

"Alpha" and "beta" brasses being unaffected by the rate of cooling, only the "alpha beta" brasses are amenable to heat treatment.

59/41 *Brass.*—Reverting to the aforementioned equilibrium diagram, it will be seen that at 730 deg. C. the "alpha" constituent is gradually absorbed by the "beta." By rapidly quenching from this temperature the structure is fixed and the tenacity and hardness are increased at the expense of the ductility and impact strength. By tempering, *i.e.*, letting down the hardness by heat, this "beta" constituent is decomposed, the "alpha" again falling out of solution, and at 600 deg. C. the normal structure is again restored.

The value of this to high-strength brasses coming within the "alpha beta" area is apparent to all and presents real possibilities, as demonstrated by a casting of which the composition was:—Cu., 60.5; Zn., 33.65; Al., 2.80; Ni., 2.96; and Fe., 0.08 per cent., which gave, as cast, 16.0 tons per sq. in. yield point, 36.7 tons per sq. in. max. stress, 19.0 per cent. elongation on 2 in., and 21.5 per cent. reduction of area, associated with Brinell and scleroscope hardness numbers of 125 and 18 respectively. After being heated to 789 deg. C., water quenched, and re-heated to 450 deg. C. for 30 mins. and cooled in the furnace, the alloy gave 28.0 tons yield point, 46.2 tons maximum stress, 18.0 per cent. elongation, and 21.5 per cent. reduction of area. The Brinell scleroscope hardness numbers were 272 and 32 respectively, the test results of which after treatment compare favourably with some of the best-made forged and heat-treated carbon steels. Whilst the heat treatment of "alpha beta" brasses may be exploited advantageously, more harm than good will result if not scientifically performed, for unless the "alpha" constituent is completely absorbed on heating and quenching sufficiently drastic, both the strength and ductility are impaired rather than improved.

To be continued.

Col. T. W. Pearson, chief engineer of the Alexandra Docks, Newport, retired at the end of July, as well as Mr. Johnson, locomotive superintendent to the Taff Vale Railway Co. Mr. H. P. Price, general manager (Brecon and Merthyr Railway Co.) has intimated his intention of resigning

Safety in Pulverised-Coal Plants.

In the "Proceedings" of the Engineers' Society of Western Pennsylvania appears an interesting article on "Explosion Hazards in Industrial Plants Due to the Use of Pulverised Coal," by Mr. L. D. Tracy, Coal Mining Engineer, U.S. Bureau of Mines. We give the following extracts from his conclusions, in which he outlines precautions necessary to the safe operation of pulverised-coal installations:—

There should be absolute cleanliness and freedom from any accumulations of dust, both in the pulverising plant and in the buildings in which the pulverised coal is being used as fuel. Accumulations of dust on the floor or machinery should never be brushed or swept up without either wetting the dust or thoroughly mixing it with an excess mixture of fine incombustible material. All coal-pulverising plants should be adequately ventilated and lighted, and, when practicable, some methods of cleaning by vacuum systems should be installed, whilst all open lights in and around such plants should be prohibited, and employees should not be allowed to smoke while in the building.

The drier and drier furnace should be separated by a fireproof partition from the pulverising mills, conveying machinery and storage bins, and where furnaces or boilers are equipped with individual fuel bins, these bins, if possible, should be isolated from the boilers or furnaces. Moreover, all pulverised coal bins should be tightly closed and never opened if there is any possibility of ignition from an open flame. Bins should be equipped with automatic indicators to indicate the amount of coal in the bin.

Only men of proved reliability should be entrusted with the direct operation of a drier. Especial care should be taken in order not to overheat the coal in the drier, and recording pyrometers should be installed to enable the officials of the plant to check the operation; the drier should never be stopped while it contains a charge of coal, and fire in the drier furnace should never be started with paper, shavings, or any light combustible material.

Because of the liability of spontaneous combustion, fine coal at a temperature over 150 deg. Fah. should never be stored in a bin. For the same reason, storage bins for pulverised coal should never be placed in close proximity to furnaces, boilers, steam pipes, or flues. Whenever a plant is to be shut down for a few days, all storage bins should, if possible, be emptied of coal. Where it is not possible to empty the bins, they should be thoroughly inspected for hot coal before the plant is again put in operation.

In the circulating system of using pulverised coal the primary air-pressure should always be maintained at a much higher pressure than that of the secondary air. If a coal-circulating line becomes plugged up, the furnaces should be immediately cut out and the secondary air stopped. After the line has been cleaned it is essential that no smouldering particles of coal be left in the line, and before starting the fan, a thorough examination of the line should be made. Burners should be frequently inspected, and any coke burned thereon should be removed. Circulating lines should be blown clean of coal when shutting down at the end of the day's work. The mixture of air and coal in the furnace should never be ignited by reaching in, or opening the doors. All conveyers and elevators should be tightly enclosed and should never be opened while running. Before opening, the machinery should be stopped and the dust allowed to settle.

All electric wires and cables should, as far as possible, be enclosed in conduits. Switches should be placed outside the pulverising plant or placed in dust-proof casings, whilst non-sparking motors or motors in dust-proof housings should be used in the pulverising plant. Precaution should be taken against sparks from static electricity in all rapidly moving machinery by having it thoroughly guarded.

All electric-light bulbs should be kept from accumulations of dust, and all portable lights should have the bulbs protected by heavy wire guards, and care be taken to prevent arcing from loose socket connections, or imperfectly insulated cords.

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.*

By Enrique Touceda (Albany, New York).

(*Continued from page 77.*)

Oven Control.

The ovens are controlled by means of a recording pyrometer, the element of which should be inserted in the centre of a pot, located close to the side-wall, as it is the temperature of the castings that is desired, and not that of the oven atmosphere. If this procedure is not adopted there is no certainty as to when the castings have arrived at temperature, and consequently the time at which the castings are held at temperature will be an approximation instead of a certainty. This design of oven has given every satisfaction, and is being installed quite generally as new ovens are needed, or the principles embodied in the design are adopted in so far as practical in the remodelling of old ovens

Electric Heating.

For some years the author has endeavoured to find some manner in which temperature control could in some way be made fool-proof. The electric resistance oven seemed to be the only solution, but the cost was found to be prohibitive. The thought finally took root that it would prove to be perfectly practical if instead of using electricity alone, to use a combination of any fuel, supplemented at certain times by electric heat. In operation the oven and contents are to be heated in the ordinary manner by coal, and the firing continued during the period at which the castings are to be held at temperature, but so regulated that the temperature produced through this means and during this period should be some 150 deg. F. (83 deg. C.) lower than required, the deficiency in temperature being supplied by electric current controlled by a potentiometer. It was thought that through this procedure not only could the temperature easily be maintained within a range of 10 deg. F. (5 deg. C.) or less if need be, and lowered at the rate desired, while through the proper proportioning and location of the resistance-ribbon the temperature could be maintained practically the same throughout the entire oven at the particular period when this is essential. In order to prove out the practicability of this scheme an oven was rigged-up quite recently with the necessary number of grids of resistance-ribbon and the other necessary details, in which two anneals have been run through. While a little trouble was experienced during the first anneal, owing to some of the hanger-block, on which the ribbon rested, parting, this was corrected in the second trial, which was carried through without a hitch. The author believes that in the future electric heat will be used in the oven to supplement carbonaceous fuel of any character. These trials have demonstrated that by means of an electric current controlled by a potentiometer the heat can be maintained in practically a straight line while the castings are being held at temperature, and that the rate of cooling can be controlled with exactness by means of the same instrument without any attention on the part of the heat treater. The cost of current is but nominal, and it is expected that the resistance ribbon will last for a period of at least 15 months. This scheme permits of the use of electricity in any oven, almost irrespective of its design, and actually makes possible the assurance that the most uncertain step in the process can be made fool-proof. In all other methods of heat treatment the heat is applied at the top of the oven, and it is a problem to induce it to come downward and towards the corners in the manner desired. With the resistance coils properly spaced and placed near the floor this trouble vanishes. Another advantage resulting from the use of the gas-producer principle is the fact that very cheap grades of coal can be used. The author is confining his remarks to the coal hand-fired ovens, as these are the ones in general use.

Oil and Natural Gas Firing.

Where oil and natural gas can be had cheaply these successfully can be used in properly-designed ovens. In using these two fuels, however, the author believes that the oven should be designed in such a manner that the firing will take place at each end alternately at intervals of about 20 mins. In this manner better control can be had than if the oven is fired at one end or at both ends at the same time. If castings are being made that are not liable to kiln warp, the muffle oven is the type to build. The best construction of muffle is through the use of the Manion-type of brick. This brick is very thin in the direction in which the heat is to flow, but is reinforced by webs designed to carry the load, with the result that the heat can be transmitted to the inside of the muffle quickly and economically owing to the thinness of the brick. If the muffle is made of carborundum brick a very strong and lasting muffle will result, through which the heat can be transmitted some six times more quickly than through a clay product. These bricks are very strong, have a low co-efficient of expansion, and, under the conditions to which the muffle is subjected, would never spall.

Grinding.

Concerning the matter of grinding, the practice at the present time is evenly divided between grinding in the hard or grinding in the soft, with a tendency to the latter method and the use of the rubber-bonded wheel. Unless there is a good exhaust system in use with the grinding apparatus the odour imparted by the rubber wheel is quite objectionable, but otherwise not. Many plants grind the light castings in the hard with a vitrified wheel, but all heavy work in the soft. When the gates exceed a certain size the pneumatic tool is used to advantage.

Sands.

There is little to be said about the moulding sand except that the problem is one of increasing difficulty. Many are troubled owing to their inability to obtain a sand sufficiently free from bases to avoid the fusion of the sand to the surface of the castings so tightly that cleaning is made difficult. It is interesting to note that in cases of this kind in which, in spite of drastic tumbling, a crust of sand still adheres, particularly at fillets or recesses, that a very short application of the cutting torch will speedily remove it, owing to the difference in the rate of expansion of the crust and the iron.

Foundry Losses.

Regarding foundry losses the following is representative. In general automobile work the hard- and soft-iron losses will approximate 15 and 4 per cent. respectively. While the latter may seem high, inspection is extremely rigid and the losses that result from straightening are not inconsequential, while defectives returned by the purchaser will often run as high as 2 per cent. It is safe to say that 20 per cent. of the castings poured are rejected at one stage or another. In the case of railway work the losses are not as heavy, and will not exceed a total of about 9 per cent., and while the inspection to which these castings are subjected also is rigid it is not so exacting as in the case of the other. In agricultural work the average loss will approximate 5 per cent. In addition to the foregoing it is well to estimate that the loss due to grinding will prove to be about 1 per cent.

Runners and Risers.

The author believes that losses due to misruns and defective casting can be minimised through a study similar to the one he has undertaken, and which he believes is new. The idea is illustrated in some accompanying photographs, and to which

* This Paper was the American Foundrymen's Exchange Paper and was read before the Birmingham Conference of the Institution of British Foundrymen.

reference will be made in due course. Some years ago the author was called in consultation in connection with a heavy foundry loss on certain sizes of piston rings. The rings were nested and gated together and poured in multiple moulds. On analysing the situation it was found that the loss was confined mostly to two sizes. The manner in which the problem was attacked was to take five single moulds and short-pour them, that is, pour a very small amount of iron in the first mould, a little more in the second, a little more in the third, and so on to the fifth. In this manner the travel

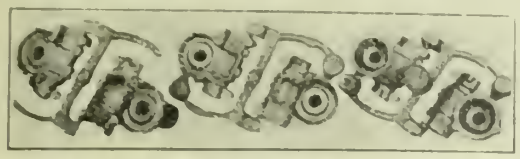


Fig. 5.—Showing Examples of Short Pours.

of the iron could be followed exactly, as if the mould had been made of glass. Briefly, the problem was solved by a change in the gates and runners in a manner that was contrary to the precepts that were heretofore considered orthodox. To conserve space, and because members are as fully able to analyse the situation as is the author, photographs are submitted without comment, which show some interesting examples of what short-pouring will disclose. In the case of all of these tests the moulds were carefully levelled in two directions before the molten metal was poured into them. Lack of time has prevented the author securing such patterns as might have illustrated in a more exaggerated manner what he has attempted to set forth, while also he regrets the fact that he was unable to secure photographs of short-poured castings of a larger and more complicated design; but he believes that, in spite of this, the cases he is submitting to show the value of the information that can be obtained from a study of this character are sufficient. (See Figs. 5, 6, 7, 8, and 9.) The vital necessity of having the gate leading to all patterns on both sides of the central runner exactly of the same shape and area as far as each pair is concerned; the area of the gates of each pair changed in accordance with what is disclosed by the short-pouring test, and the runners so tapered that the flow of metal will be more evenly distributed to each individual pattern in the flask, to

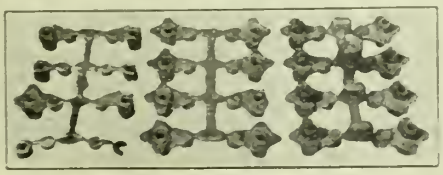


Fig. 6. Another Example of Short Run Castings.

the end that each one will be taking the metal each as rapidly as the other. The casting shown in Fig. 10 is an eloquent testimonial of the length to which the founder is willing to go in his effort to insure the integrity of the casting. In this case the risers weigh more than the casting, but in addition to this expedient permission was obtained to place a strap on the casting shown at A, leading from the gate of each of the four heads upward towards the fillet, whereby a wide channel, for the metal to reach the top of the casting is created, and in this manner the formation of a shrink such as can be seen in Fig. 11, at the fillet where the smallest diameter swells gradually into the larger one, is prevented. Even with the precautions referred to a very light shrink will be seen in the etched section right opposite a very sharp corner. If permission could be obtained to round off this corner it would result in the disappearance of the shrink. In taking on new work the founder should not only experiment with the pattern until he has satisfied himself, through the breaking up of the hard-iron castings in many small parts, that shrink

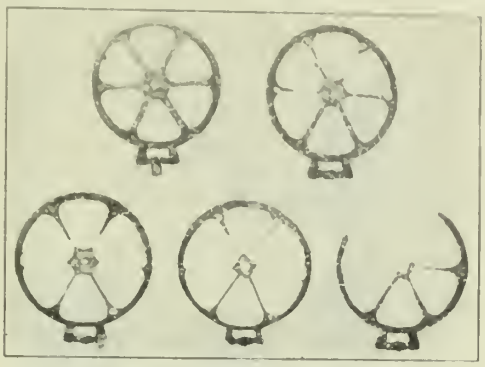


Fig. 7.—Small Wheels which have been Short Run.

is absent and that he has ascertained the best method of gating and heading the casting, but after he has finally arrived at this decision he should anneal some of the castings in order to confirm this conclusion. Slight porosity is difficult to discover in a fracture of hard-iron, and it oftentimes happens that upon breaking up the annealed casting, which in its hard condition was supposed to be perfectly sound, it is found to contain some

Fig. 9.—A Typical Example of Short Run Castings.

shrink. It might be well to note that in the author's experiments on shrink he has found that whether the iron was poured hot, medium, or fairly dull can be told by the colour of the shrink. When poured very hot it is black, when poured at medium temperature it is more or less very dark grey, while the shrink resulting from metal poured fairly dull is very light coloured.

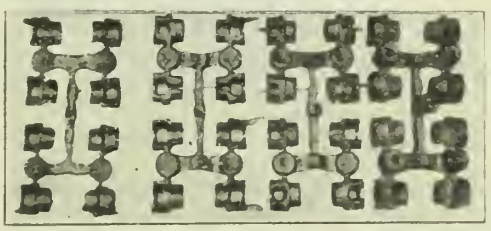


Fig. 8.—Another Group showing the Same Defect.

Composition Limits.

What are the permissible limits for the various elements in the hard-iron is a question the author has been asked with frequency. Owing to the inter-relations of these elements the answer on its face appears to be complicated. While admitting the complexity of this inter-relation, actually as far as practical work is concerned there exists little reason why this fact need necessarily complicate

the proposition. As previously set forth, with all other elements balanced a silicon-content of 0.90 per cent. in the hard-iron yields very desirable properties, for when heat-treated it is resolved into a silico-ferrite matrix that, considered alone, is strong and ductile and of splendid machinability.

It has been established that the strength and ductility of this matrix is weakened by high total-carbon, and that improvement takes place as this element is lowered. The limit to which this safely can be carried without detriment to the fluidity and life of the molten metal, or increasing the tendency of the castings to crack or check on cooling to an objection-

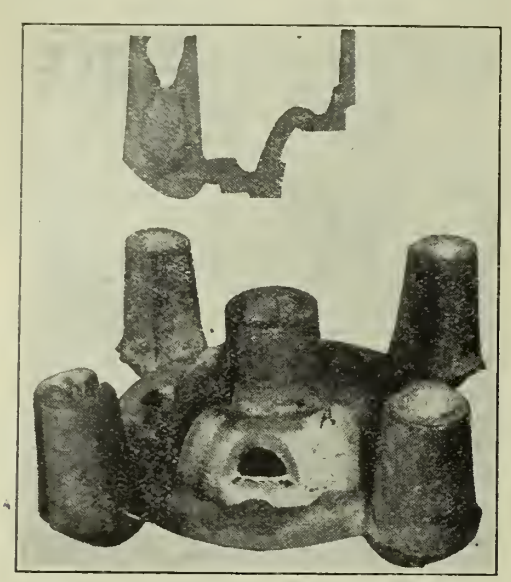


Fig. 10.—An Example where Risers Weigh More than the Casting.

able extent, may be assumed to be, say, 2.35 per cent. The phosphorus appears to be in no sense detrimental up to 0.20 per cent. Inasmuch as no difficulty exists, nor is any expense attached to the adjustment of these three elements at these percentages, they can be eliminated from the problem and the disturbing elements considered to be sulphur and manganese only as far as these five elements are concerned, or consider the silicon, carbon, and phosphorus to be the datum, and work from there as a start. While it is not difficult to

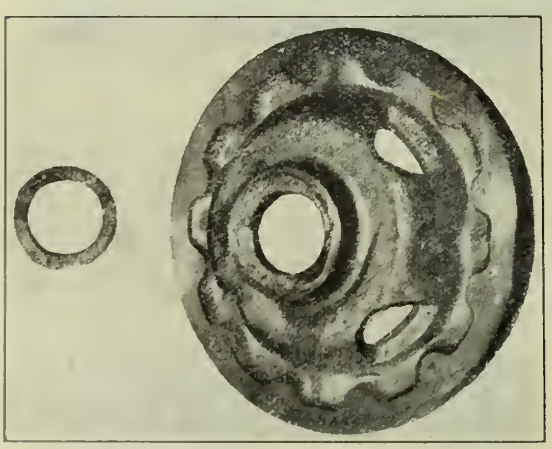


Fig. 11.—An Example of the Shrink Defect.

purchase low-sulphur pig and fairly low-sulphur scrap, it is getting increasingly difficult to secure low-sulphur fuel. Also in some localities it is rather difficult to purchase pig with manganese as low as is desirable.

The question, then, really resolves itself into what are the permissible limits for the sulphur and manganese. While it is generally conceded that these elements should be present in atomic proportion to form manganese sulphide, the author has seen many instances in which the product was excellent where this was not the case. Based upon data obtained from the testing of many test bars, the author would state that with a sulphur content between the limits of 0.05 and 0.08 per cent. it is safe to use a manganese content between the limits of 0.20 to 0.30 per cent., with the recommendation to avoid using, coincidentally, the high-limit for manganese with the low one for sulphur, and contrarywise. The manganese should be increased with increase in sulphur, and with the latter at 0.12 per cent. it should lie between 0.34 and 0.40 per cent. It happens, however, that at this percentage of sulphur the metal has a frame-producing tendency, by which is meant that upon annealing the carbon, instead of diffusing out of the iron in a manner that will leave a decarbonised surface-rim of ferrite, surrounding a core of normal structure, there will exist between the ferritic rim and normally-structured core a partition ring of pearlite. Just why a very low-silicon-manganese mixture will produce an iron having this tendency, and just why a high-sulphur iron with insufficient manganese will do the same, the author does not know; but he does know that such is the case, and that when the metal is in this condition not only is the material hard to machine but that probably it will fail in service. In the absence of a decarbonised surface ring it does not appear possible to obtain a true frame, while, on the other hand, the presence of a decarbonised surface rim does not appear to act to produce a frame except under certain conditions that will be touched upon. The conclusions that follow may be correct, and they may not. It is not possible in regular practice to heat an ordinary ferrous metal in a heating furnace or annealing oven atmosphere without decarbonising the surface to a certain depth, whilst the same thing takes place when a grey-iron, a hard-iron, or a steel casting is stripped from the sand and exposed to the air while still red-hot, and, to some extent, even if they are not stripped at that temperature, for, as there is air in the mould, some decarbonisation will take place on that account.

Frame-Producing Mixtures.

Assuming then that all hard-iron castings have a partially-decarbonised surface prior to being heat-treated, it is quite certain also that the hotter the iron as it enters the mould the more complete and the deeper will be this decarbonised surface. If the practice is such that the molten metal is given a high degree of super-heat in order that it can be distributed in large ladles, the moulds first poured will have a deeper decarbonised surface than those last poured, and are liable to develop "frames."

Now, while it is essential that a decarbonised surface must be in existence before a frame can be produced, it is the author's belief that it is the rate at which the carbon in the core tends to diffuse into the decarbonised rim and the completeness with which the carbon continues to be removed from this rim that determines whether or not a localised carbon-content will be built up and maintained in equilibrium at the junction of the two, while the fact that test-wedges from the same heat, but annealed in different pots, have been found in which one wedge was framed and the other not, must lead to the conclusion that the rate of diffusion referred to plays an important part in the story. Then again the author has proved that the depth of frame is a function of the temperature, for in the case of wedges poured from the same ladle in the same flask, and heat-treated at different temperatures, the heaviest frame in every case accompanied the highest temperature. In the case of frame-producing mixtures the composition must be such that the rate of diffusion favours the building up of the pearlitic ring. The author is inclined to believe that this attitude towards the frame-producing mixtures is entitled to some weight. It is a problem that the author has endeavoured to obtain time to properly investigate, but without avail to date.

(To be continued.)

Great Britain and Spain.—A commercial agreement has been signed in Madrid by the British and Spanish commercial delegates. At a largely attended meeting of industrial and commercial delegates, held at Oviedo last Monday, a resolution was adopted protesting vigorously against the clauses of the Bill for this Commercial Treaty, particularly as regards the clauses concerning coal. The resolution was wired to the Government.

Trade Talk.

Mr. G. Culley, metal broker, has removed to 57, Fenchurch Street, London, E.C.3.

Parker, Winder & Achurch, Limited, have established offices in London at 40, Craven Street, Strand, W.C.2.

Wright & Son, engineers and press tool makers, of Edgware, will in future carry on business under the style of Chas. Wright, Ltd.

Extensive damage has been done by a fire which happened recently, at the premises of Gould's Foundries, Limited, Barry Dock.

Mr. H. T. Middleton, iron and steel merchant, of 39, Great Tower Street, London, E.C., has removed to 16, Water Lane, Great Tower Street, E.C.3.

J. J. Thompson & Son, iron and steel and metal merchants, of 3, York Street, Manchester, have established a branch at 47, Exchange Buildings, Birmingham.

The rolling mills at Winlaton Mill, which were established by Sir Ambrose Crowley in 1691, are being dismantled by Messrs. Raine and Co., of Derwenthaugh.

Alexander Jack & Company, Limited, crane makers, Motherwell, have removed their London office to 11, Cartaret Street, Queen Anne's Gate, Westminster, S.W.1.

Mr. E. Mayhew, 5, Billiter Buildings, E.C.3, has been appointed London representative of the North-West Rivet, Bolt and Nut Factory, Ltd., Hogg Street, Airdrie.

The Association which administers Health Insurance for the Sheffield steel manufacturers has recently acquired Stubben Edge Hall, at Ashover, Derbyshire, which has been converted into a convalescent home.

Operations have been started in connection with the filling up of the West Harbour, Greenock. This harbour has been acquired by Harland and Wolff, Limited, for the purpose of filling in to extend the east side of their yard.

The ascertainment of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board for May and June shows the average net selling price to be £11 6s. 6d. This means a decrease in the wages of 5 per cent. on basis rates.

The Directors of William Beardmore & Company, Limited, propose increasing their borrowing powers from £3,000,000 to £4,000,000, which is necessitated through their shipbuilding contracts with the Lloyd Sabaudo Company of Genoa.

Mr. William Sharp, constructional engineer, has removed his offices to 11, Cartaret Street, Queen Anne's Gate, Westminster, S.W.1. Mr. Sharp is the London representative of Wright, Anderson & Company, Limited, Gateshead-on-Tyne.

The forgemasters of the North-East Coast Engineering Trades Employers' Association have given notice of their intention to reduce wages by 16s. 6d. a week in three instalments as follow: 5s. 6d. on August 21; 5s. 6d. on September 11; and 5s. 6d. on October 9.

The secretary to the National Union of Blastfurnacemen, in his annual report, points out that the average weekly wage in the iron and steel industry fell from £5 7s. 11d. in September, 1920, to £3 8s. 2d. in October, 1921, and that 60 per cent. of the blastfurnacemen are now unemployed.

As illustrating the downward trend of prices, made possible by the forthcoming reduction in wages, we see that Hollings and Guest, Limited, Thimble Mill Lane, Birmingham, are at once making a reduction in the price of their all-metal bundling press, which can now be purchased at the list price of £20 net, f.o.r. Birmingham, cancelling the 20 per cent. advance which has been charged up to the present.

The annual golf competition of the Liverpool Metal Trade was again held on Thursday, July 27, on the links of the West Lancashire Golf Club. The winner of the cup was Mr. J. D. Crichton, while the second prize, presented by Mr. George E. Lewis, was tied for by Messrs. T. G Alexander, H. A. Scott-Barrett, and A. H. Atkins. After the competition dinner was served, Mr. George E. Lewis presiding. The joint secretaries of the competition are Mr. Sidney E. Booth and Mr. Roscoe D. McKay.

The adjourned hearing took place, last week, before a Board of Arbitration, of the case of the South Wales and Monmouthshire Iron and Steel Manufacturers' Association *v.* the National Union of Amalgamated Building Trade Workers. The case related to the wages of a section of bricklayers and masons employed at Dowlais, Ebbw Vale and Tredegar Works. Another adjourned hearing took place with regard to the wages of bricklayers' labourers employed at the Blaenavon Works. The decision was reserved in each case.

The output of the Clyde shipyards for July was 11 vessels of 32,961 tons gross, which compares with 16 vessels of 34,900 tons in June. The [illegible] the other Scottish districts were only 2 vessels of 7,250 tons. The year to date has dropped far to leeward in comparison with former average years. The total tonnage put into water in the seven months just closed consists of 73 vessels of 200,454 tons, whereas last year in the corresponding period there were 131 vessels of 265,248 tons, and in 1913 there were 146 vessels of 377,270 tons. There has been a decrease, therefore, compared with last year, of 58 vessels of 64,794 tons. Some inquiries have been in circulation lately, including one, it is reported, for a 12,000-ton passenger steamer, but so far as can be ascertained, no actual contracts have followed.

The directors of the Consett Iron Co., Limited, in their annual report, state that there is no real indication of the demand for iron and steel improving, whilst the costs of production continue to be much above selling prices. The new Victory Pit at Consett has been working for part of the year. Good progress has been made with the construction of the coke and by-product works at Consett; the manufacture of silica bricks at Templetown has commenced; the site for the new steel works is ready, and a contract has been placed for the erection of the building needed to house five steel-melting furnaces shortly to be erected; the erection of four gas producers and the boiler repairing shop is nearly completed; one of the two turbo blowers is erected, and the second one is ready for delivery; the turbo generator and the three water-cooling towers are in use; the company's first housing scheme, covering the erection of 464 houses, has been completed, and the subsidy from the Ministry of Health obtained.

Company News.

United States Steel Corporation.—Quarterly dividend, 1¼ per cent. on common stock.

Henry Bessemer & Company, Limited.—Interim dividend on 5 per cent. non-cumulative preference and ordinary shares passed.

Allen & Daly, Limited.—Capital £1,000. General engineers, millwrights, etc. Permanent directors: W. A. Allen and U. de Burgh Daly.

George Greenwood & Sons, Limited, 301, Brixton Road, London, S.W.9.—Capital £5,000. Engineers, etc. Directors: W. P. and G. F. Greenwood.

National Gas Engine Company, Limited.—Interim preference dividend, 5 per cent. per annum, less tax; interim ordinary, 7½ per cent. per annum, less tax.

Alexander Hannah & Company, Limited, McGowan Street, Paisley.—Capital £10,000 in £1 shares (5,000 preferred ordinary). Engineers, machine makers, etc. Directors: T. White and J. Thomson.

Amalgamated Bolides Company, Limited, 35, Charles Street, Hatton Garden, London, E.C.—Capital £100. Ironmasters, steel makers and converters, etc. Directors: C. C. Lyon and W. N. Lyon.

Consett Spanish Ore Company, Limited.—Net revenue, £5,046 18s. 2d.; brought forward, £473; interim dividend, 1s. per share, £2,760; final dividend, 1s. per share, £2,760; carried forward, £6,199.

Frank Whatton, Limited, 32-4, Theobald's Road, London, W.C.—Capital £1,100 in 1,000 shares of £1 and 2,000 ordinary shares of 1s. Engineers, etc. Directors: F. Whatton and C. H. Bowser.

Vickers, Limited.—Interim dividends, 2½ per cent. on preferred five per cent. stock (less tax), 2½ per cent. on five per cent. preference (less tax), and 2½ per cent. on cumulative preference shares (free of tax).

L. G. Morgan, Limited, Crown Buildings, James Watt Street, Birmingham.—Capital £1,500 in £1 shares. To adopt an agreement with G. Morgan, and to carry on the business of iron, steel and scrap merchants.

Consett Iron Company, Limited.—Profit, £102,446; brought forward, £302,085; available, £404,532; income tax, £210,188; interim preference dividend, £20,000; final preference dividend, £20,000; ordinary dividend, 4 per cent. per annum, free of tax, £120,000; special expenditure, £13,673, extinguished; carried forward, £20,669.

Brightside Foundry & Engineering Company, Limited.—Dividend for 1922, 7½ per cent., free of tax; profit for year ending June 30, 1921, £13,870; brought forward, £2,285; available, £16,155; interim dividend for first half-year on £45,000 5 per cent. preference shares, £1,125; half-year's preference dividend to June 30, 1921, £1,125; ordinary dividend, 10 per cent. per annum, free of tax, £9,964; reserve account, £2,000; carry forward, £2,211

IRON AND STEEL MARKETS.

Pig-iron.

With the majority of the pig-iron markets suspended during the holiday week, transactions in all classes of ferrous material is virtually suspended, while it is not anticipated that the re-opening will be attended with any excessive activity in business. As illustrating the comparatively idle conditions now obtaining in the trade, may be evidenced the latest returns of the plants producing at the present time, showing that out of 486 furnaces erected in the United Kingdom only 117 were in blast on June 30, an addition of 16 since March 31, a reduction of productive capacity significant of the critical times through which the industry is passing.

Finished Iron.

Movements in the market for finished material of late, though still restricted to buying on a limited scale, suggest some revival of interest in this section of the trade, which, it is confidently hoped, may develop into further expansion of business in the near future. Significant of this improving tendency is the restarting of some of the works long idle in the South Staffordshire area, consequent probably upon a better inquiry for finished iron, mostly in the form of bars and other material in increased request for the electrical and engineering branches. General expansion of demand is, however, retarded by present high costs of production, which have only lightened to a limited extent by the recent reduction in rail freights for raw material.

Steel.

The gradual improvement previously noted in the general outlook of the steel industry is fully maintained, the volume of inquiries and new orders now in circulation almost justifying the optimistic sentiments so freely expressed in trade circles within the past few months of depression. In support of this view may be noted an increasing flow of specifications for mild steel, chiefly from Colonial and foreign buyers.

Steel prices for the home trade, with the exception of boiler plates, are now free, and have been reduced to £9 for ship plates, £8 15s. for sections, and £12 10s. for boiler plates.

Scrap.

There are few distinctive features to note in the existing condition of trade in scrap metals, the general tendency of markets remaining quiet, with the exception perhaps of some qualities of steel material, for which there seems a partial revival of demand. Middlesbrough, a fairly representative market, reports that there is not much business passing in iron and steel scrap just now. Heavy steel scrap is still comparatively in most active demand, and the price is now at a minimum of 62s. 6d. per ton delivered at works. Other prices are nominal, and unchanged, as follows, all delivered works :—Heavy cast iron machinery scrap in handy pieces, 79s. to 80s.; steel turnings and cast-iron borings, each 45s.; heavy wrought-iron, bushelling and piling, each 62s. 6d.; special heavy forge, 70s. to 75s. per ton.

Tinplates.

Holiday influences have been a retarding element in the week's tinplate market, and only a moderate volume of business has been reported. The home trade seems to be holding orders back, and the little business done during the past week or so was on a low basis, viz.; 19s. for coke tins, f.o.t. at works. Export buyers report that they have very few orders to place. Prices are all on the easy side, transactions being reported in the standard sizes as follows :—Coke finish, IC, 14 x 20, 112 sheets, 108 lbs., 19s. 9d. per box, for prompt delivery, and 19s. 4½d. for September, net f.o.b. Wales.

Metals.

Messrs. Henry Bath & Son, Limited, in their fortnightly metal report, under date August 2, 1922, state :—

Copper.—The advance recorded in our last report has continued very steadily so far as standard copper is concerned, but electrolytic has hardly moved. Good buying of the former has been witnessed throughout, and the daily turnover has reached quite respectable figures. Stocks continue to dwindle. Scrap copper and scrap brass are fetching better prices as supplies grow less. Current quotations:—*Cash*: Wednesday, £65 7s. 6d.; Thursday, £65 7s. 6d.; Friday, £65 2s. 6d.; Tuesday, £65 2s. 6d. *Three months*: Wednesday, £65 7s. 6d.; Thursday, £65 7s. 6d.; Friday, £65 2s. 6d.; Tuesday, £65 2s. 6d.

Tin.—From the opening day of the past fortnight prices have consistently moved upwards. The prospects during July of favourable statistics at the end of the month induced heavy bear covering, and large buying orders could only be executed at steadily advancing prices. A noticeable feature lately has been the gradual elimination of the contango until all positions were dealt in at one price. American buyers as usual have not followed the market up, probably partly deterred by the uncertainty prevailing there regarding the settlement of the coal and railway strikes. Sales from the East have been moderate in quantity and at full prices. Current quotations:—*Cash*: Wednesday, £159 15s.; Thursday, £159 2s. 6d.; Friday, £160 17s. 6d.; Tuesday, £161 12s. 6d. *Three months*: Wednesday, £159 15s.; Thursday, £159 2s. 6d.; Friday, £160 17s. 6d.; Tuesday, £161 12s. 6d.

Spelter.—A strong market has ruled throughout, the advance reaching about £2 5s. per ton for distant, and nearly £3 for near delivery. Shortage of supplies continues to be the principal reason for this advance, added to which consumers have been buying freely principally for prompt delivery, and even higher prices may soon be seen. Current quotations:—*Ordinary*: Wednesday, £31 17s. 6d.; Thursday, £31 12s. 6d.; Friday, £31 15s.; Tuesday, £31 15s.

Lead.—This market has improved about £1 a ton during the fortnight, the strength being most noticeable in the near position, which at one time commanded a premium of 30s. per ton over forward. The difference between August and November is not so marked, but will probably increase during the month unless supplies become more plentiful. Current quotations:—*Soft foreign (prompt)*: Wednesday, £25 17s. 6d.; Thursday, £25 15s.; Friday, £25 15s.; Tuesday, £25 10s.

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THE

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Contents.

	PAGE
Some I.B.F. Historical Notes and its Future	127
A French Opinion of Semi-Steel	128
Gazette	129
The Foundry of the Renault Works	130
Institution of British Foundrymen	131
An Apprentice Course in Foundry Practice—V. ..	132
X-Ray Investigation on Metals	135
British Opinions on Making Castings without Feeding Heads	136
Making Castings without Feeding Heads	140
Institute of Metals	141
American Methods of Manufacture of Malleable Iron Castings and some Data in Connection with the Finished Product	142
Production of Foundry Coke from Non-Coking Coals	144
The Development and Manufacture of High-Tenacity Brass and Bronze	145
Some Notes on Belgian Foundry Practice	147
Trade Talk	148
Company News	148
Deaths	148
Iron and Steel Markets	150

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Large Resistance Furnaces.—In an interesting article on "Industrial Electrical Heating," by Mr. J. G. Pearce, B.Sc., in the July issue of "The Metropolitan-Vickers Gazette," the author refers to the large resistance furnaces employed in America. During the war very considerable strides were made in the applications of these wire-wound furnaces, and the largest types were actually used for heat-treating gun forgings. These large furnaces use nichrome ribbon in sections up to 2 in. wide by $\frac{1}{8}$ in. thick in loops supported by refractory insulating members projecting from the wall of the furnace. The furnace is 24 ft. high and 6 ft. dia. inside dimensions. The rating is 400 k.w. at 440 volts, 60 cycles. It was found that seven 4-in. tubes (22,300 lbs.) took 1,880 k.w.-hours and three 4-in. water jackets (21,700 lbs.) took 2,088 k.w.-hours. The weight treated per k.w.-hour amounted to 11.25 lbs., making 200 k.w.-hours per ton. A furnace is under construction of 10 ft. 6 in. dia., 105 ft. high, taking 2,850 k.w.-load and 320,000 lbs. of steel.

Some I.B.F. Historical Notes and its Future.

At the Birmingham Convention, mention was made of the presence of so many founders of the Institution. It is not generally known that the Institution was started as a result of correspondence in the columns of THE FOUNDRY TRADE JOURNAL. Mr. F. W. Finch, who is still Honorary Treasurer of the Institution, taking the advice of Mr. John G. Stewart, of Urmston, wrote to the Editor of THE JOURNAL for the names and addresses of his correspondents. The result was that Mr. Finch called a meeting at the Cobden Hotel, at Birmingham, on April 9, 1904. At this meeting Mr. Finch met Messrs. Robert Buchanan, who was elected the first President of the Institution, F. J. Cook, J. Ellis, C. Morehead, F. W. Shaw, and W. Vickers. Both Mr. Cook and Mr. Ellis afterwards passed through the presidential chair. Mr. Morehead, who is now living in London, has just transferred his membership from the Newcastle to the London Branch. The first Convention was held in Manchester the following August, and 43 members were present, the roll having grown in the meantime to 98, an infinitely better proportion than is obtained nowadays. A pleasing feature was that at that date everybody had paid his subscription. It is a pity that present-day balance-sheets have fallen from the original high standard. This factor of arrears is interfering with the excellent work which the Institution carries out. Programmes have to be curtailed, lecturers from a distance cannot be invited, and visits to works have to be kept to minimum on account of expense.

At this first meeting a model presidential address was given by Mr. Buchanan, and two scientific papers read by Dr. Longmuir and Mr. W. T. Maccal. We have noticed that some present-day stalwarts are always complaining that the papers now presented are too theoretical. Yet it was on theoretical papers that the Institute was nursed. Perhaps the great difference between the papers of two decades ago was that the readers seemed to possess a gift of making difficult problems appear simple. Nowadays, a lecturer occasionally gives one the impression that it is as much as he can do to understand his own conclusions. Foundrymen are to be congratulated that this type is rare amongst their lecturers. In general, the Institution has made enormous strides since its inception. Its general council meetings are now occasionally as large as the first general meeting. Summarised, it has been granted a Royal Charter; it has created a research organisation; it has already organised an international meeting, and at its next Council meeting will decide as to whether it is desirable to hold its next Conference in Paris, as an invitation has been received from the French foundrymen's association to do so. In this manner it will be following the lead given to it by the older associations. Once the principle is established, no doubt in future years Belgium, Scandinavia, Italy and perhaps the States will be visited. Such visits cannot be otherwise than beneficial to the industry as a whole, but obviously, should such an arrangement be accepted, there should also be a spring meeting, in order that those unable to go abroad can meet their President and fellow members. This would cover any objection that could be raised by those unable to participate. The status of the foundryman has been improved by its representative technical association, and all that remains to be done is to follow intelligently the path indicated by its energetic founders.

A French Opinion of Semi-Steel.

Mons. E. Ronceray, of Paris, in a written communication on Mr. J. Cameron's Paper on semi-steel, stated that he congratulated Mr. Cameron for his very interesting Paper, and thanked him for his too kind appreciation of his (Mr. Ronceray's) Paper on a similar subject given to the A.F.A. during the war.

He (the writer) was not very proud of his Paper, as he fell in a good many points in accepted errors of this time. His excuse is that it was then more urgent to help making shells than to argue.

Mr. Cameron considers the name of "semi-steel" as misleading, and he suggested that some translation of the French name, "fonte aciérée," is used. Perhaps "steely cast iron" would answer the purpose.

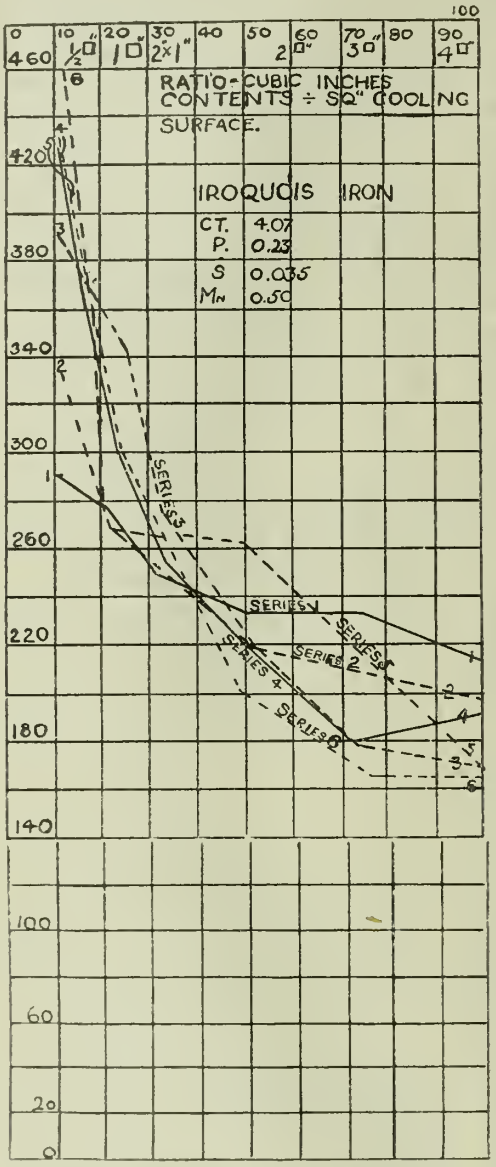

Fig. 1.—Asme Tests as Measured.

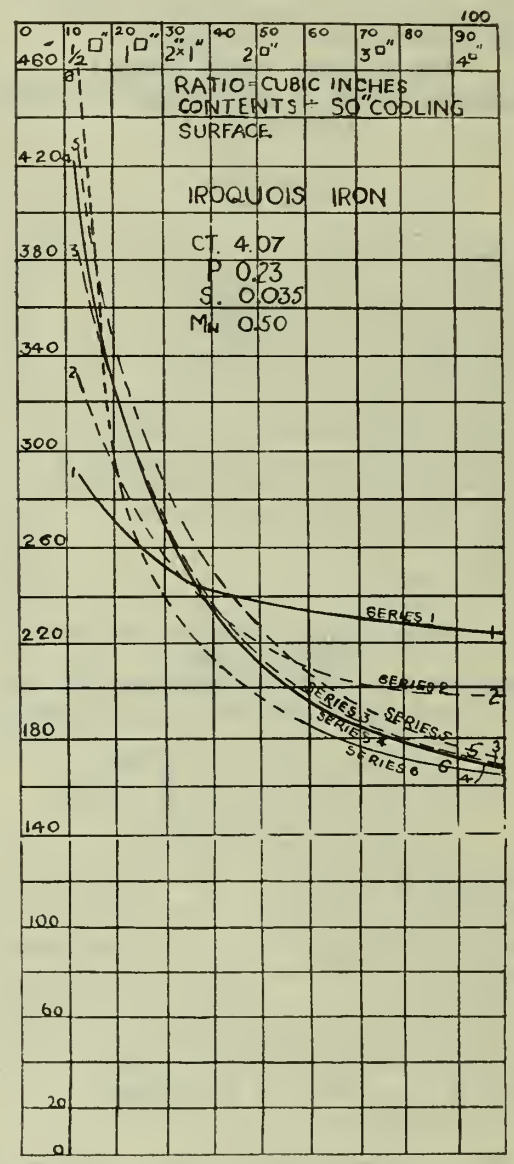

Fig. 2.—Curves Made Uniform.

So far as he could understand, the tests imposed by the British War Office were simply those of the French War Office translated in English measurements. The same criticism that he made in his Paper, "New Methods of Testing Cast Iron," applied. Those tests were valueless.

Colonel Prache mentions: "What has stopped possible improvements with semi-steel during the war are the tests imposed by the War Office. Those who have made semi-steel shells know that these tests had a very distant relation to the castings that were to be produced"; and also "War Office tests prevented foundrymen from making better shells." Portevin writes: "On the point of view of the quality of metal for projectiles, it was difficult to make a worse choice of testing methods."

The reasons were fully explained in his Paper, and he only wishes to warn those who have not had a long experience of these tests not to put the slightest confidence in them. Another proof of their unreliability is given by Mr. Cameron when he mentions that failures happened when the foreman had changed the moulder making the test bars. In fact, it is quite common that two bars cast in the same moulding box from the same gate give quite different results.

High Silicon in Cas Iron.

A point of Mr. Cameron's Paper which interested the writer considerably is his statement about high silicon test pieces. It refers to one of the writer's hobbies. Professor Turner did wonderful pioneer work when he investigated, more than 35 years ago, the influence of silicon on cast iron. He called attention to the importance of silicon on the condition of carbon, and gave a chart showing the influence of silicon on strength of cast iron. From this time the behaviour of silicon has been studied, and we are indebted to him for the considerable progress that has been made in the foundry in following the information given. About same time, on different lines, Gautier in France used silicon in cast iron to a great extent.

Professor Turner worked on what must be called artificial cast iron containing about 2 per cent. carbon, and used test pieces of only one size. Unfortunately, though Professor Turner mentions this point very clearly, many false ideas have been derived from the insufficient knowledge of these details.

After Professor Turner, Keep, the admirable American experimenter, made very important researches on the same question, dealing with commercial iron and using various sizes of test pieces, but he tested transversely, the most reliable of all tests for cast iron. He ventured to say that Keep was rather influenced by the results published by Professor Turner, for it seems that he did not

dure to draw the full lesson from his tests. Fig. 1 shows the original diagram of pages 120-121 of "Cast Iron," by W. J. Keep, amended only in showing the zero line that Keep left out, beginning his diagram at 160 lbs. This was done only to save space, but it was rather misleading. Alongside of it (Fig. 2) is shown the diagram corrected by him to make nice curves, and amended by the writer in the same way as the preceding one. It is quite clear that in the first diagram there is a knot of all curves between ¾ in. and 2 in. thickness, which the writer should translate by saying that between ¾ in. and 2 in. thickness a percentage of silicon between 1 in. and 3½ in. makes no difference in the strength.

The writer has poured castings of about 1¼ in. thickness and even more with cast iron intended to be used for thin work, and containing more than 3 per cent. silicon, and the work was quite satisfactory. He has made this now for more than four years, with the result that a hard casting is almost unknown when other conditions are normal in the foundry.

Table I.—*Composition of the Iroquois Iron used in experiments detailed in Fig. 1.*

Series.	Per cent. nominal silicon.	Per cent. of silicon. ½" sq.	1" sq.	1" × 2"	2" sq.	3" sq.	4" sq.	Si. av.
1	1.00	0.83	0.79	0.78	0.82	0 72	0.88	0 81
2	1.50	1.09	1.14	1.70	1.33	1.10	0.88	1.20
3	2.00	1.73	1.73	1 70	1.50	2.17	2.50	1.88
4	2.50	2 13	1.69	1.60	1.80	2.17	2 07	2 01
5	3.00	2.42	2.65	2.40	3.36	3 67	4.67	3.19
6	3.50	2.74	2.69	2.70	2.62	4.30	3.22	3 04

Other conclusions could be drawn of a careful examination of Keep's diagram, but this is not the place to examine them. He hoped to be able to return to the subject later, but he was pleased to read in Mr. Cameron's Paper full support of what he had found when Mr. Cameron mentions that a gate 1¼ in. dia. containing over 3 per cent. silicon, yielded a tensile strength over 18 tons. At the same time, he mentions that semi-steel seems sensitive to phosphorus and sulphur.

Phosphorus in Semi-Steel.

Referring to phosphorus, he believed that we do not seem to speak the same language when we speak of high phosphorus in semi-steel in France and in Great Britain. In Mr. Cameron's Paper, in semi-steel analysis the P is from 0.39 to 0.73. It is when there is 1 per cent. phosphorus that one considers phosphorus high. In France, semi-steel for shells has always been made with hematite, and the question is to know if the limit of from 0.06 to 0.07, or exceptionally 0.12 per cent., can be passed. He sincerely believed that it would be a great mistake to insist upon such low figures, for up to 0.30 the strength and probably the brittleness of cast iron is not altered.

Colonel Prache is afraid that it will probably be brittle. Careful experiments must be made to determine if such is the case, for the price of commercial semi-steel would considerably rise if the lowest figures are insisted upon.

The Limit of Sulphur Content.

The sulphur in analyses given in Mr. Cameron's Paper (0.150 and 0.143 per cent.) was not balanced by a proper amount of manganese; this is probably the reason why the iron would not run in small bars. The manganese ought to have been at least 0.50 to 0.70 instead of 0.26 and 0.34. Thousands of tons of semi-steel shells have been made in France with such percentage of sulphur (see analysis in the writer's Paper on "New Methods of Testing Cast Iron," where the sulphur varies from 0.12 to 0.22). These high percentages of sulphur are not to be recommended, but this resulted from the poor material available during the war, and it is comforting to know that they can be occasionally accepted.

Blow Holes.

Mr. Cameron shows test-pieces with blow-holes due to retarding the pouring. Many reasons can be the cause of such blow-holes, either what the writer calls "Custer effect" (air entrained with iron in pouring), or slag inclusions, or gas from either the mould or the metal. So it is of no use to discuss this point, so long as no more details are available about the condition of pouring, but this is not special to semi-steel, under similar conditions common cast iron would behave similarly. Damp sand, when used for ordinary cast iron, will produce the same result.

Cupola Practice.

He quite agreed with Mr. Cameron as to the size of cupolas to be used and their general arrangement with only one row of tuyeres and the rate of 1 to 4, but he differed with him about the interest of small charges. He was at one time of this opinion, and he had altered it, because, when the charges are small—that is, corresponding to 4 in. thickness of coke as recommended by Dr. Moldenke—the coke takes fire through the charges of iron too easily, and after a short time the flame appears to the top of the cupola, which then is working as a gas producer burning a large amount of coke for nothing and rendering the working of the cupola very hard. He had come to the belief that a thickness of 6 to 8 in. of coke and a corresponding thickness of metal are to be recommended. It means that in a 40-in. cupola he would not use charges less than 14 cwts. iron for 12 per cent. coke ratio.

Referring to the melting of steel, Mr. Cameron says that steel melts quicker than iron, pig and scrap. He was very surprised to read that it is a fact that the melting of succeeding charges takes place more or less simultaneously, especially when the charges are small.

Dr. Moldenke gives an evidence of such fact in his Paper of this year presented to the Rochester Convention of the A.F.A. But to admit what Mr. Cameron mentions needs more evidence than he gives. Very likely the pieces of steel melted first were of smaller section than the pig or scrap that he used. This would be a satisfactory explanation.

Gazette.

Messrs. A. Deacon and J. H. Quarton, stamped brassfounders, 97, Rea Street, Birmingham, trading under the style of A. Deacon & Company, have dissolved partnership.

The partnership hertofore subsisting between Messrs. S. Pritchard and T. W. Etchells, engineers' merchants, 5, John Dalton Street, Manchester, under the style of Thomas W. Etchells & Company, has been dissolved.

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The first meeting of the creditors of Mr. W. S. Harle, of South Shields, trading at Waverley Chambers, South Shields, as an iron and steel merchant, was held in Newcastle. The Official Receiver said debtor had lodged a statement of affairs, which showed liabilities amounting to £1,564, and assets to £230. Debtor was asked a number of questions about his trading, but on the suggestion of the Official Receiver, it was agreed that the matter should stand over until debtor was upon oath at his public examination. It is a summary case, and the Official Receiver is a trustee.

At the Sheffield Bankruptcy Court, on August 3, Mr. W. J. Ritchie, Freedom Works, Sheffield, came up for his public examination. His statement of affairs shows a deficiency of £44,808. In answer to the Official Receiver, he stated that in 1908 he became a partner in the firm of William Hall and Company, of St. Mary's Road, Sheffield. Six months later he became sole proprietor and changed the trading name to W. J. Ritchie & Company. In 1911 he removed the business to Arundel Lane, Sheffield, spending £9,000 in plant and machinery. Before the outbreak of war his turnover was about £60,000 to £80,000, but afterwards this increased to £140,000 in connection with the Ritchie business and £150,000 in connection with the Crookes, Roberts & Company business, which he purchased in 1918 for £35,000. He entered into Government contracts for shells to the value of £60,000 to £70,000, and took a number of sub-contracts for the manufacture of aeroplane cylinders, the total of these being £80,000. The deliveries of these contracts were suspended by the Government, and at that time the debtor had £23,000 worth of finished cylinders on the premises. These had to be disposed of as scrap, and only realised £350. He attributed his failure to loss on Government contracts. The examination was adjourned to October 26.

The Foundry of the Renault Works.

The house of Renault, whose works are at Billancourt in France, claim themselves to be the largest manufacturers of motor-cars in Europe. They also claim to be unique, insomuch as that they can carry out, practically without any outside help, the whole of the operations necessary for the mass production of motor-cars. To do this they have had to build the various foundries of which the outstanding particulars are dealt with in this article.

Fig. 1.—General View of the Heavy Castings Foundry.—Messrs. Renault's Automobile Works, Billancourt, France.

Steel Foundry.

This is the largest shop in the Works, with the exception of the Forge and Stamping Departments. It occupies three bays, each one being 7,250 metres square, and is served by five overhead cranes. The metal is melted in four cupolas which feed four converters, each one being capable of making three tons per hour. The moulding is practically entirely accomplished on the machine, there being no less than 40 moulding machines of all sizes in this Department alone. Additionally, there is an up-to-date mechanical and preparing plant served by transporters and elevators, which carry the sand to each machine, thus reducing labour to a minimum. In normal times no less than 500 tons of steel castings are made each month.

Fig. 2.—Cupola Installation in the Heavy Castings Foundry.—Messrs. Renault's Automobile Works, Billancourt, France.

Iron Foundries.

In order to ensure an efficient organisation, Messrs. Renault have built three iron foundries, each one being devoted to its own speciality. Primarily, there is a grey iron foundry, specially designed for the casting of cylinders and, generally speaking, most of the castings which enter into the making up of a motor-car. The plant contained in this foundry comprises two three-ton cupolas, two overhead electric cranes, 24 moulding machines, and a mechanically-operated sand-preparing plant.

Additional to the above there is a grey iron foundry specially laid out as a foundry for machinery castings. It is furnished with three cupolas designed to produce 15 tons of liquid iron per hour. This shop is served by three overhead cranes. During the war there was cast in this foundry a casting weighing no less than 130 tons.

These two foundries are supplemented by a third one devoted to the manufacture of malleable iron. Three two-ton cupolas melt the necessary iron, whilst 30 moulding machines and a battery of eight annealing furnaces complete the installation.

The monthly production of these three foundries is 200 tons from the cylinder foundry, 200 tons from the machinery castings foundry, and 130 tons of malleable iron.

Brass and Aluminium Foundries.

These two foundries, which turn out all the non-ferrous castings used in the Works, are supplied with the most modern apparatus. The brass foundry is furnished with three tilting furnaces, eight moulding machines and mechanical sand-preparing plant. It turns out 80 tons of non-ferrous castings per month. The aluminium foundry contains the following plant: 11 tilting furnaces and 25 moulding machines, each one being served by small hydraulic jib cranes. Two overhead cranes span the shop, and, as is the case with all the other foundries, mechanical sand-preparing plant is provided.

In this foundry a section is devoted to chill castings, by which means mass-production castings are made, including gear and engine casings. The output of the aluminium foundry is normally about 80 tons per month.

Mr. John J. Ash has severed his connection with the British Thomson-Houston Company, Limited, and has entered into partnership with Mr. R. J. D'Arcy Hart, at 70, Victoria Street, London, S.W.1, where they are carrying on business as engineers under the name of Ash & Hart.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

The annual excursion of the Lancashire and Burnley Branches of the Institution of British Foundrymen this year took the form of a visit to the Works of the Staveley Coal and Iron Company Limited. About 80 members attended, and a most enjoyable day was spent. The members were met at Chesterfield station by char-a-bancs and conveyed to the Staveley Works, when they were taken round the new Devonshire Works.

At 1 p.m. a most enjoyable lunch was provided. At lunch the company was joined by Mr. Chas. Markham, the head of the firm, and members of the staff.

After lunch the party were taken round the pipe and jobbing foundry, the visit coming to an end at 4 p.m.

Mr. J. Hogg proposed, and Mr. J. Haigh seconded, a hearty vote of thanks to the firm for their generosity and their kindness in making the visit a perfect success.

The thanks of the members of the branches are also due to Mr. G. P. Raundrop, for the trouble he took and the able arrangements he made for the success of the visit.

Fig. 3.—One of the Foundry Bays, Messrs. Renault's Automobile Works, Billancourt, France.

A Large Motor.—A new reversible electric motor developing 18,000 h.p., built by the Société des Atéliers de Constructions Electriques de Charleroi in Belgium, has lately been installed at the works of the Société des Forges de la Providence, at Charleroi, for driving their large blooming mill.

Brooklyn Suspension Bridge.—Reports from New York state that the Brooklyn suspension bridge across the East River is causing some anxiety among engineers, who point out that the bridge, although capable of standing strains far in excess of those for which it was originally designed, was never meant to bear the strain of heavy high-speed motor traffic, which for the time being has been stopped. Brooklyn Bridge, the centre span of which is about 1,600 ft., has several times been strengthened during recent years, but there is no means of reinforcing the four steel cables on which the main span depends. These cables are 15½ in. in dia., and each is capable of supporting a weight of about 12,000 tons. The actual weight of the bridge is 24,000 tons. The bridge comprises a footway, four tracks for subway trains and trams and two roadways, which reach a height of 135 ft. above the water-level.

An Apprenticeship Course in Foundry Practice.—V.

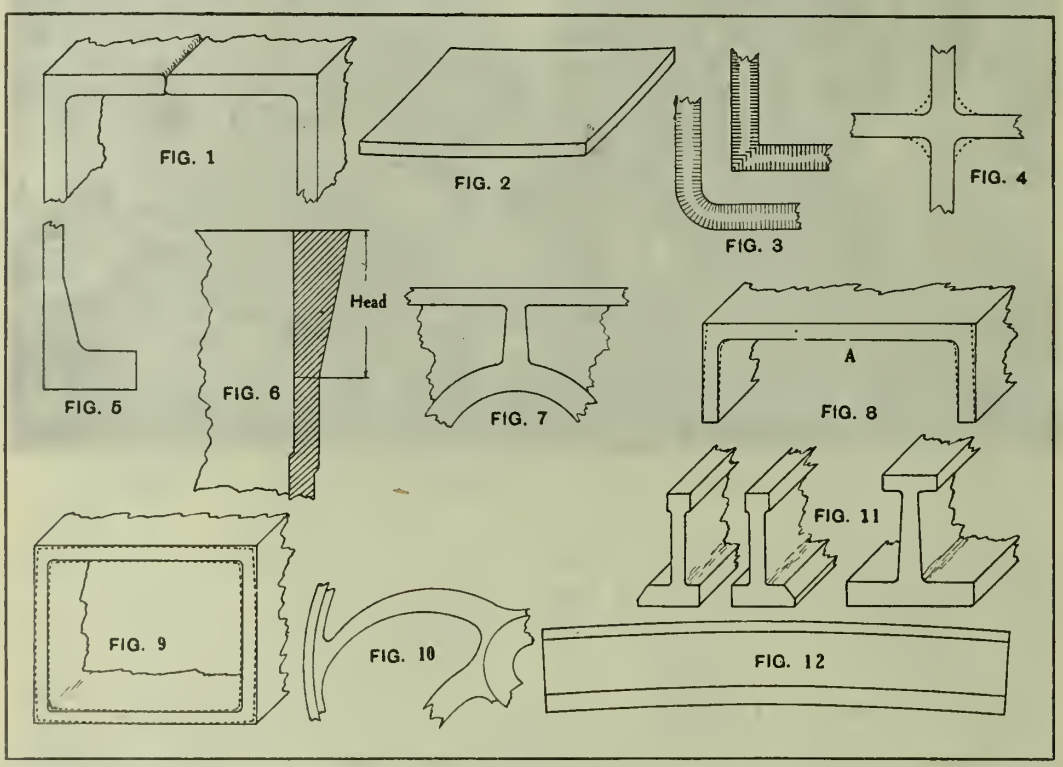
By Ben Shaw and James Edgar.

SHRINKAGE AND CONTRACTION—GENERAL CONSIDERATIONS.

When metals are heated, they expand, and when their temperatures are reduced to normal, they contract. This is a very important consideration in all structures involving the use of metals. In constructional steel work, such as bridges, special precautions must be taken to allow the steel work freedom to expand and contract, according to the varying temperature to which it is exposed. Rails, too, are set with a clearance between contiguous lengths, and the bolts through the fish-plates which secure them are eased as the atmospheric temperature increases, in order that the rails will be free to expand and thus reduce the possibility of them buckling. Even on buildings, where there is considerable steel work, it is necessary to make special allowances. It will probably interest many readers to learn that the Crystal Palace varies in length between winter and summer as much as 6 in. sometimes, because of the effect of the varying temperatures upon the steel work. The variations of temperature to which these are exposed are small in comparison to metal that is to be cast, and, as the change of volume is more or less proportional to its temperature from the molten to the normal condition of the solid casting, it follows that all those who are directly employed in the production of castings is subjected and the manner in which castings are influenced by the change in form comprise the greatest drawback to the production of sound castings. It is a constant source of worry and anxiety to the founder, particularly when a wide variety of castings are being produced, and his ingenuity and experience are often taxed to the utmost in devising means for reducing the effect of contraction on the increasingly complicated castings of to-day.

Crystallisation.

To understand the manner in which a casting is likely to be influenced by contraction, let us briefly consider how the metal contracts. It should be pointed out that, while the foundryman does not always regard shrinkage and contraction as separate action, they are indeed such. Shrinkage applies to the molten metal, and contraction applies after solidification has taken place. Between the two actions there is a distinct period. Directly the metal has been cast it begins to crystallise about the mould, that directly in contact with the mould surface solidifying first. The crystals arrange themselves at right angles to the surface, and the temperature is reduced from the outside to the inside, crystals gradually attaching themselves until the whole has become solid. Practically speaking, it may be asserted that, as soon as the mould is full of metal, a skeleton of



must of necessity take into account the reduction in volume from the molten state. In the case of cast-iron, the metal expands at the moment of solidification; according to Keep, there are three distinct expansions, after which the contraction continues gradually until the temperature is normal

Not only is it necessary to consider the change in volume or contraction to give it the recognised expression, but its influence upon the casting is equally as important. In constructional steel work the designer is responsible for the necessary allowances being made, and they are incorporated in the design, but in the production of castings it is mainly the moulder or founder who is made responsible, though the designer and the pattern-maker have an important part in assisting to reduce the difficulties of the founder caused by the shrinkage and contraction of metal. These difficulties are experienced to a more or less degree with every casting, and it is safe to assert that the shrinkage and contraction to which the metal the casting, consisting of solid metal, has formed against the surface of the mould, due to the rapid reduction in temperature. But the heat of the metal is not so rapidly given off away from the surface of the metal; thus it solidifies gradually from the outsides to the centre, and the time in which the whole casting will become solid will depend upon the fluidity of the metal when molten, the metal used, and the thickness of the casting.

Thin and Thick Sections.

The thin sections of a casting solidify more rapidly than thick sections. The comparatively cold mould absorbs the heat quickly, and the metal has not sufficient "body" to maintain any part of it in a molten condition; therefore, thin sections of metal solidify so nearly at one time that any slight difference in time of cooling between the outer surfaces and the centre is practically negligible. It is, in fact, necessary to increase the pouring temperature of metals which are to be used for castings having a light section, because

the temperature is reduced to such an extent in contact with the mould that, unless this precaution is taken, solidification takes places before the mould is completely filled, or, though the mould may be filled, parts may not properly connect. The metal is then said to be "*cold shut*." This simply means that, as the metal rises in the mould, its temperature is reduced to such an extent that, when ends meet, they are not hot enough to unite as shown in Fig. 1. But, while thin sections solidify almost immediately, it applies only to thickness and not to area. In casting a plate, for instance, the edge as well as the top and bottom of the mould absorb the heat from the metal, and this additional mould surface at the edges reduces the temperature of the plate out of proportion, which causes the casting to buckle or twist, in the manner shown in Fig. 2. Thick plates do not buckle so readily, because the cooling action is more prolonged, and they possess more "body" to resist bending.

The conditions differ considerably when the metal section is thick. A skeleton consisting of solidified metal is formed directly against the surface of the mould, but the increased body of metal causes it to maintain its heat longer, and the change from the fluid to the solid state of the full section is spread over a varying length of time. The difference in the time of solidification after the metal has been poured has an effect upon the amount the metal contracts. In thin sections that solidify throughout almost at once, contraction is regular, but with thick sections the contraction of the outside shell is restrained by the fluid metal inside, and instead of the metal contracting regularly, as in the case of the thin sections, the section becomes drawn and the texture of the metal more open towards the centre. Although the metal still contracts, it is not wholly external contraction, and the remaining fluid metal in the section not having sufficient power to draw the solid metal surrounding it, causes a certain amount of internal segration, which may be termed internal contraction. It is this fact which causes some hydraulic cylinders to "sweat," particularly when the metal thickness is greater than is necessary. Then the texture of the metal may be such that water may be forced through under test-pressures.

When castings are composed of both thin and thick sections, and there is considerable difference in the thickness, the metal must be poured hot enough to run the thin sections successfully, and, as these solidify quicker, they draw upon the metal in the thicker sections. In this way strains may be set up between sections of a casting which may be so severe as to cause a rupture, either before the casting has been removed from the mould or during the operation of cleaning it. Castings should therefore be so designed that the metal thicknesses are comparatively regular. Uniformity of thickness is rarely possible, however, as flanges must be increased in thickness, bosses cast-on and machining allowances made. The casting may be subjected to varying stresses necessitating various thicknesses of metal, or parts may be reduced in thickness merely to lighten the casting or to improve its appearance. In many cases, sections of a casting are made thicker than is necessary because other sections must be thick. This form of modification of the design to assist the founder is not always made in the drawing office, although it ought to be. When varying thicknesses must be made, they should be made as gradual as possible, in order that the cooling stress will be distributed over a wider area and not located in the angle of the abrupt change.

The Value of Fillets.

Fillets, as was briefly explained in the article on pattern-making materials, should be introduced wherever possible, not only to give greater strength by the increased amount of metal, but to prevent the weakness due to the crystal formation at re-entering angles. The enlarged sections in Fig. 3 show the comparison. A certain amount of discretion must be observed in the size of fillets used; thus, when two plates of metal intersect, as in Fig. 4, large fillets, illustrated by dotted lines, should not be used, otherwise the plates will draw upon the larger body of metal in the centre. While fillets are necessary when the sections adjoining are of similar thickness, they are almost essential also when an angle is formed between two sections of varying thickness, and when the contrast in thickness is great, fillets alone do not suffice to graduate the change of shape. It is better practice, and more helpful to the founder, to make the connections as gradual as possible, particularly in the case of steel castings. This is illustrated in Fig 5, which shows a heavy flange cast to a comparatively thin body; the wedge portion prevents the abrupt change, and, though the cooling strains cannot be entirely eliminated, the contraction between the sections is more gradual. This is frequently termed reinforcement. Another illustration showing the need of a gradual change between metal thicknesses is shown in Fig. 6. This is the form of head commonly cast on cylinder liners. Its thickness is greater than that of the liner, in order that it will be last to solidify, but, to reduce the resultant strain upon the liner, a gradual taper is given to the head. We are of the opinion that strains would be further reduced if the continuity of the head was broken by introducing cores in three or four places. This graduated thicknessing should be adopted also for webbing or ribs which are connected to sections that have considerable difference in their thicknesses in the manner shown in Fig. 7, just as it is considered necessary in the design of various forms of pulleys and wheels that have thin rims connected to comparatively heavy bosses.

Moulding Methods and Contraction.

In addition to the influence of varying thicknesses upon the contraction of the casting, different sections contracting against each other, together with the resistance offered by the mould, frequently alter the shape of the resultant casting, even when the sections are of similar thickness. Consider a casting having extended flanges at each end, but otherwise straight, as shown at Fig. 8. The length of the section A will tend to contract normally, but the resistance of the mould will prevent the flanges contracting to the same extent. The force exerted by A in contracting will draw those parts of the flanges in contact with it, and the mould will be crushed, but the influence of A is not sufficient to draw the full depth of the flanges the same amount. The resulting casting would, therefore, have a shape resembling that shown by the dotted lines. This is purposely exaggerated in the sketch to show clearly the contraction which may be expected to take place. Should the mould be too strong and offer greater resistance than the metal can overcome, then a fracture is almost inevitable, particularly with cast steel or aluminium, and, in a lesser degree, cast-iron and brass. If the illustration be extended so that the internal part of the mould is more fully enclosed, the metal surrounding it, as in Fig. 9, the sides of the boxed casting would contract in the same manner, but the sides would have very little influence in assisting the central parts to overcome the resistance of the mould. An exaggerated illustration of the influence of contraction in this instance is shown by the dotted lines in Fig. 9.

In each of the instances given above ribs or brackets may be introduced in the design to assist in maintaining the requisite shape, and, even though these would be helpful, they are not by any means a guarantee, and the moulder must take the necessary precautions to so weaken the internal mould formation that it will give to the pressure of the casting. But the mould must be strong enough to resist the pressure of the metal when fluid, so that in complicated work the resistance of the mould or cores and the counteracting influences of different sections prevent that amount of contraction which would be expected if the casting was straight.

Contraction Pulley Arms.

When the metal sections vary in thickness, similar influences operate, but they are accentuated by different rates at which the metal cools. Almost every reader will be familiar with the shaped arms in pulleys. These are sometimes referred to as contraction arms, because they "give" to the strain which is exerted upon them; thus their use prevents fracture or releases strains that would result in fracture ultimately. The rims of pulleys are thin for lightness, while the bosses are

comparatively thick to give the requisite strength, the arms being tapered for the reason already given. After the metal has been poured for such a casting, the rim solidifies almost immediately the mould is filled, while the metal in the boss remains in a fluid state for some time afterwards, and, when contracting, it pulls upon all the arms which are connected with the rim. When the arms are straight, there is every likelihood of a fracture either of the rim or, more frequently, one or two arms are broken at their weakest section near to the rim. When the contraction arm is used, such as is shown in Fig. 10, the tension upon it merely tends to straighten it, and a fracture is averted. In large fly wheels the same difficulty is experienced, but it is diminished by constructing it segmentally or by separating the periphery in a number of places in order that, by localising the contraction, strains may be practically eliminated.

Camber.

Varying sectional thicknesses are equally as difficult when they are desired in castings which are long compared with their depth or breadth. There is then a tendency for them to warp, and an allowance has to be made when constructing the pattern, which is commonly called "camber." Castings such as lathe beds, girders, etc., are types subject to this change of form, cross-sectional views of which are shown at Fig. 11. The earlier contraction of the lighter section is contained by the fluid metal of the heavy section, and as the latter cools to a normal condition, it pulls upon the lighter section, which has become almost set, and in consequence the heavy section is more or less concave, as shown in Fig. 12, according to the contracting power of the heavy section overcoming the resistance of the lighter section. The method of ramming a thin layer of sand on top of the thick section after the metal has been poured and the core removed equalises cooling, and thus reduces the tendency to warp. If such a precaution is for some reason impossible, then the amount of camber necessary, while it may be approximately estimated by a man who has had a great deal of experience with the particular class of work in hand, can be determined accurately only by trial. Even when the pattern-maker has made a calculation based on a comparison of a casting with his pattern, it is necessary that the same moulder should be employed on subsequent jobs, or, at any rate, that similar moulding methods should be adopted, or there may be no improvement.

Pattern Allowances.

The pattern-maker is frequently responsible for modifications in a design with a view to facilitating the production of a casting in the foundry and to increase the prospects of a sound casting. He can only do this successfully, however, when he is working in close co-operation with those responsible for the work in the foundry. In addition to any slight alterations, such as the introduction of fillets, rounding corners, making abrupt changes of metal thicknesses more gradual, introducing webs or ribs or varying their positions, cutting through a wall of metal or increasing the size of hole through some unimportant part of the casting, he is also responsible for external contraction allowances. Moulds must be made larger, so that the metal cast in them will conform to requirements when cooled down, and just as metals and alloys vary, so do the constants for making the necessary allowances on the patterns. It would be comparatively simple if a definite constant could be used for each metal or alloy to be cast. Those young pattern-makers whose work has been executed without any departure from the recognised contraction allowance for cast-iron of 1-10 in. to the foot will probably be surprised, as they acquire more experience, with the number of variations from this rule. Different mixtures of the same metal vary in the amount of their contraction, according to the influence of their components. Grey-iron contracts less than white iron. Light castings contract more than heavy castings; thus for guttering pipes and any light work which has little or no obstruction to contracting, an allowance of $\frac{1}{8}$ in. to the foot is common practice. Then work of a complicated nature contracts less, depending upon the counteracting influences. An allowance of 1-16 in. to the foot is very frequently used for such work, and in some instances no allowance at all is made. These latter cases are exceptional, and refer to such cases as breeches pipes, when the centres between two branches, according to their design, are set out with the standard rule, or in semi-circular castings open at the ends and carrying an additional structure on the crown, which causes the diameter to open rather than contract. Even in the making of one casting the allowances often vary for different parts. A large reciprocating cylinder is a case in point. Usually 1-16 in. to the foot is allowed on all dimensions excepting the height, and with this practice varies considerably. Some make no allowance for contraction, but take the precaution to have additional machining allowance; while others allow for contraction, but are careful to back up the flanges in order that, if the casting should not contract the amount for which allowance has been made, the flanges will at least be thick enough after they are machined. It is not suggested that castings do not contract to the same extent vertically as horizontally, and the method of moulding is a probable cause, for it is well known that moulds have a tendency to "creep" when there are many joints. It is the practice of some pattern-makers, because of this, when constructing small and medium-sized work, to make distances from the main horizontal joint less than indicated in the drawing; thus, for grey-iron work the measurements would be made with a standard rule, and for brass work with an iron contraction rule.

Common Allowances.

The general allowance for cast steel is 1-5 in. to a foot, and for work up to, say, about 2 ft. it is quite satisfactory, but above that it is profitable to get in touch with the foundry doing the work, for their contraction allowance may be anything from 5-32 in. to $\frac{1}{4}$ in. to the foot, according to the work to be cast and the composition of the steel. The temperature at which the metal is poured influences the amount of contraction. There is another allowance to be considered with steel castings, which, though not concerned with contraction, should be made when the castings are to be annealed. The pattern is usually prepared to give at least 1-16 in. increase in the thickness of metal to allow for the removal of the scale which is formed on the surface after the casting has been annealed.

The usual contraction allowance for brass and gun-metal is 3-16 in. to the foot, but 5-32 in. to the foot is in common use for large work, slight variations being made according to the shape of the casting, and determined as the result of experience with similar types of castings. For aluminium, an allowance of $\frac{1}{4}$ in. to the foot is in frequent use, though many use the contraction rule for cast-steel or brass for comparatively small work, but in complicated work an allowance of 7-32 in. to the foot is sometimes used.

Strain-Reducing Devices.

Even though the designer and pattern-maker may have exercised their faculties to the utmost in order to assist the work in the foundry, it must be admitted that much remains for which the moulder must be responsible. It is his duty to so construct the mould that, while it supports the metal during the time of casting, its resistance is such that the contracting casting will overcome. In loam-work, straw rope or wood-wool rope is used for this purpose, and chopped straw and sawdust in the loam mixture; these burn after the metal has been cast and reduce the strength of the loam.

Loam bricks are used in preference to ordinary bricks when there is a possibility of the latter offering too great a resistance, whereas the loam brick will crush. Cores which are usually subject to the pressure of the metal from all sides merely consist of a shell of loam, the inside being filled with ashes. It is important to give ample clearance to grids or plates used to support cores. Artificially-bonded sands lose their bonded qualities to a considerable extent in the presence of the hot metal, making the sand fragile and more easily influenced by the contracting casting.

Ramming up wood blocks at the back of awkward projecting parts of a casting, which are withdrawn and their impressions filled with silver sand, have considerable value for weakening moulds

Although precautions of this nature may be taken, they may not suffice, and easing the casting by other means may be necessary. This consists in removing that part of the mould which is resisting the normal contraction of the casting, or key cores may be removed for the same purpose. The influence of unequal rates of cooling, with the consequent contraction troubles, necessitate special attention, particularly with cast-steel and aluminium. Thick parts of a casting may be exposed to the air, or they may be chilled with deusers consisting of pieces of metal introduced into the mould and against which the thicker parts of the casting come. Metal being a better conductor of heat than sand, it reduced the temperature of the casting quicker. Nails are introduced for a somewhat similar reason, but they are surrounded with metal, and become part of the casting.

Feelers are invaluable for keeping thick parts of a casting supplied with live metal to make up the deficiency due to shrinkage.

Special Webs.

Thin webs are frequently cast between adjoining sections which vary in thickness, and at an angle to each other, to reduce the possibility of a rupture due to unequal cooling, or due to the resistance of the mould at a critical time. These thin webs solidify quickly and support the projecting parts. This is very common practice in steel foundries. When patterns are sent by outside firms, an apprentice pattern-maker fits a large number of these thin webs—usually about ¼ in. thick—between adjoining walls of metal. These are afterwards cut off the casting, and the men who have made the pattern do not in many cases know the precautions which have been taken by the moulder to ensure a sound casting.

The position and area of the runners and the temperature of the metal when poured have a certain influence upon the contraction of a casting. Some moulds need to be filled quickly, while others are poured slowly by comparison. The subject of correct pouring temperature is a complex one, involving many considerations, but, as a general rule, it may be said that the temperature of the metal should be only sufficient to fill the mould completely and satisfactorily, unless the casting can be conveniently fed, when hotter metal may often be used with advantage to the casting, but having greater contracting influences.

The Value of Comparison.

The subject of contraction is extensive, although it has only been generalised in this article. Its purpose will have been fulfilled if it encourages observation in the foundry not only of the methods adopted to reduce strains under varying conditions, but the results when suitable precautions have not been taken, and many scrap-heaps bear witness to the fact that the difficulties resulting from shrinkage and contraction are not yet mastered. It is a very good practice for apprentices, if they have the opportunity of doing so, to compare castings with patterns, checking main centres and comparing contraction in different directions. A careful examination of a casting, using straight-edges on flat surfaces, will teach much. When several patterns of similar design are being made, the first casting produced will often suggest modifications which will lead to the subsequent production of castings of very accurate dimensions.

United States Steel Corporation Earnings.—The Corporation's net earnings during the first six months of 1922 and 1921, as compiled from the quarterly reports, were:—

	1922.	1921.
Net earnings	$46,626,930	$54,178,738
Dep., sinking fund, etc.	19,431,721	20,295,890
Net income	27,195,209	33,882,848
Int. U. S. S. bonds	10,089,622	10,320,211
Balance	17,105,587	23,562,637
Preferred dividends	12,609,838	12,609,838
Common dividends	12,707,562	12,707,562
Deficit	8,211,813	1,754,763

The directors have declared the regular quarterly dividends of 1¾ per cent. on the preferred and 1¼ per cent. on the common stock.

X-Ray Investigations on Metals.

Dr. R. Glockner, who has given a considerable amount of attention to X-ray investigations on metals, points out in an article in "Stahl und Eisen" that the interference photos obtained by different investigators on the same material often vary according to the technique adopted, and that a proper application of the method will only be possible when the physical principles of the process have been thoroughly studied. In this connection the writer has undertaken an investigation of steel for a large steelworks, and offers a number of suggestions as a result of his own work, and work by other investigators, on the examination of metals by X-rays.

The following, he states, are the most important factors upon which the interference image depends:—(1) The thickness of the test plates; (2) the cross section of the X-ray pencil; (3) the hardness and spectrum composition of the rays. There has been found to be a favourable thickness of sample for every material in which the interference spots occur very pronouncedly in a comparatively short time. This thickness depends upon the penetrability of the metal in question, being about 0.25 mm. for industrial steels. When preparing the test sample for X-ray examination, care must be taken to see that the structure is not altered by mechanical treatment. The writer has found the following method to be suitable: From the ingot or billet pieces about 5 mm. thick are sawn out and screwed to the wood chuck of a lathe. By means of a hand milling-cutter, a central circular section is turned out, leaving the form shown in Fig. 1.

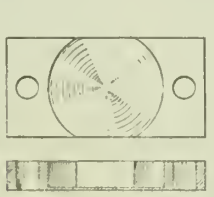


Fig. 1. Form of Samples.

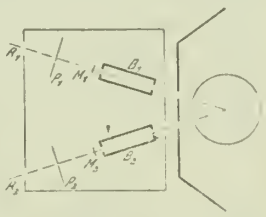


Fig. 2. Test Arrangements.

As regards the second point mentioned above, the smaller the cross-sectional area of the X-ray pencil the sharper the interference spots and rings on the photographs. On the other hand, the time of exposure should be protracted considerably, and in practice a medium must be struck between these contradictory factors. The workers in the writer's laboratory adopted a pencil of about 1½ mm. dia. Fig. 2 shows (B1 and B2) how the diaphragms are arranged, M1 and M2 show the method of setting up the samples under test, and P1 and P2 are the photographic plates. The entire arrangement is enclosed in a lead-lined box, the side of the box exposed to the rays being further protected by a lead screen. The use of two pencils of rays, R1 and R2, enables two samples to be investigated with practically the same amount of trouble as would be required for one.

The most important point is to select X-rays of favourable spectrum composition. Iron is a comparatively impenetrable material, and the tendency is to use rays of the maximum penetrability. This is correct when using the absorption process, in which the differences in density of thick pieces of iron are to be exhibited. The writer has determined the influence of the composition of the rays on the interference image by simultaneously photographing numerous compositions of spectrum by means of the spectograph and a special ray analyser. The best rays for practical purposes he found to be those whose maximum intensity is between 0.5 and 0.5 Angström (medium-hard rays).

The writer then offers the following suggestions for increasing the perfection of the process:—(1) By altering the design of the photographing apparatus (*i.e.*, arrangement of 4 or 8 pencils of rays simultaneously) the cost and time required may be reduced. (2) The most important problem is the construction of a special X-ray tube capable of giving rays of the composition required with a greater intensity of emission than is at present possible.

British Opinions on Making Castings without Feeding Heads.

Favourable Experiments Detailed

In our issue of June 1, we published M. Ronceray's Paper on the subject. The Paper was given before the London Branch of the Institution of British Foundrymen, and gave rise to an interesting discussion. The Branch-President (Mr. H. O. Slater) opened the discussion by stating that M. Ronceray had served the foundry world to great purpose, in that he had not only lectured to them in a most fluent manner, in a language not his own, but he had explained some fundamental principles in connection with moulding. He himself, like M. Ronceray, had carried out a number of experiments of the particular nature referred to in the lecture. Mr. Stone, a member, like many other foundrymen, could not accept the theory, but was convinced by practical experiments. The method was later extended to include gunmetal and other alloys. No doubt many of them were aware that malleable iron was something of a "hungry" metal, similar to manganese bronze and steel. One experiment was made, a spring bracket on a motor lorry, with a section of ½-in., with ribs leading to bosses of 3 in. dia. x 2¼ in. It was necessary, in order to get a sound casting, to have a feeding head on each boss, there being two bosses on the casting. The difficulty was not so much that of getting the metal sound underneath the risers, as in getting the risers off without knocking a piece out of the casting owing to design and the larger risers used. Necessity drove them to invention, and they cast these brackets with just a small riser, with about the same dimensions as mentioned by M. Ronceray, namely, 3-16th in. by ½ in. To make up for the feeding heads, they put 6, 9 and 12 ins. of extra height of runner on to these particular castings. The theory at that time was that the pressure would have some compensating effect for the risers. They had found that that was not altogether satisfactory in this particular case, owing to greatly unequal section, and there was difficulty with regard to the regular solidification of the metal. Having an advantage which in malleable iron they did not have to the same extent in cast iron work, owing to annealing, they put a chill on the bosses. The calculation they used was to have a chill half the size of the thickness of the boss to save the fusion of the chill and at the same time densening the bosses, and it was found that that regulated the solidification of the metal, and they got a perfect casting. They extended the method until they saved something like 20 to 25 per cent. of the melting charges on the shop as a whole. With regard to M. Ronceray's 6-in. shell, did he cast that shell with a core, and, if so, what did he allow for machining?

M. Ronceray said it was cast with a core, and he had allowed 4 or 5 mm. on the radius.

The Branch-President said that was ⅜-in. a side for machining, and M. Ronceray had achieved something great. He had saved something like 20 to 30 per cent. on the machining charges of a shell. There was one thing which had come to his mind, and that was as to whether the secret of small gates and no risers lay in the use of hot metal. He was pleased to note, from the lecture, that the French moulder was like the English moulder, in that he followed out instructions as far as he could when being watched. It gave them satisfaction to know that they could not altogether denounce the English moulder any more than any other.

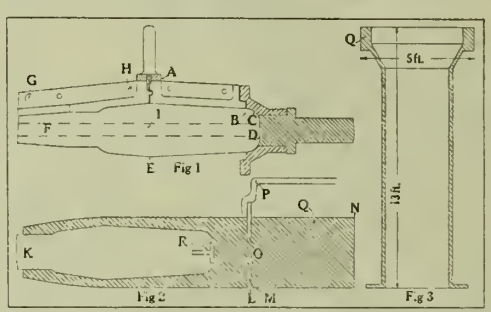
Casting Shells.

Mr. A. R. Bartlett, speaking in connection with the shell which M. Ronceray had mentioned, said that his firm had made many shells during the war, but he was sorry to have to admit that they had to cast them all with feeding heads. Their method of gating was certainly not that described by M. Ronceray, and he gave an example of their method of gating by means of a sketch. The shells were cast vertically and moulded vertically. They were made on a stripping plate machine, and possibly the way they were moulded had some effect upon the castings. They were moulded six in a box, which was round, and there was a core in each, as shown in Fig. 1. The core box is swung from the perpendicular for running to the horizontal for lifting from the box, when lifted out. It is then dipped into a blacking bin and hung on bars ready for stoving.

The reason for making heads such as are shown, was that they had a moulding machine converted to this particular use, and as it was the only machine which they thought would make them economically and quickly, they adopted that method. They had never had a reject, but they always had to break off the heads. He believed the general practice in England was to cast them, sometimes singly, in a box, but he understood many firms cast them two in a box, but with feeding heads on them. The runners were generally much smaller, when compared with what was generally accepted for a casting of that size. The castings weighed 49 lbs. each, and were for 4.5 gas shells. Six-in. shells were necessarily longer, and weighed little under 1 cwt., but they were run in the same manner, with a 9-in. head. He had had no experience of anything which was run in the manner M. Ronceray had spoken of.

M. Ronceray asked whether the feeding heads were broken.

Mr. Bartlett illustrated the feeding head, and



A=Steel band with handle each side to act as trunnions. B=Rammed first to this level with protecting cap in position. C=This cap then placed on top and rammed. Three brads put it and wire withdrawn. D=Top plug then driven in to give finished shape and length. E=Split here for ease of machining. F=Print. G=Adjustable pin holes across corner, ⅜ in. diameter. H=Bolt holes for fastening when machining, ⅜ in. diameter. I=Core bar with vent wires placed in position first. K=Core print. L=Joint of mould. M=Core head broken off here with hammer. N=Top. O=Core. P=Runner. Q=Head. R=Chill.

how it was broken, by means of a sketch, reproduced in Fig. 2.

Mr. Bartlett then instanced the case of another casting, weight 8 tons 10 cwts., with a flange top and bottom, the casting being tapered. It was rather difficult to make, as will be appreciated from Fig. 3.

M. Ronceray asked whether the head was sound.

Mr. Bartlett said that when cut off it was perfectly sound.

M. Ronceray: And the top?

Mr. Bartlett: That was also perfectly sound.

Continuing, he said he had illustrated a small and a large casting, which more or less carried out what M. Ronceray had said. There were several small things such as machine-moulded castings, which we in England would never think of putting a riser on, and M. Ronceray's theory was carried out by his own experience of a good many small things. The fact which had interested him most was the coupling running through the centre, which M. Ronceray had mentioned. He had never seen such a thing done. He was not upholding all M. Ronceray's theories, but was just giving facts as he had found them in his own experience. He would like to know whether M. Ronceray found that he obtained a different result with a different chemical analysis of his iron. Did he find it essential to have a very high phosphoric iron for running castings with fairly thin section, and with such a small runner, or could he advocate any particular chemical analysis to be successful under his system?

Mr. Hall expressed his pleasure at having heard

a lecture by M. Ronceray. About June last year the lecturer had written an article in "La Fonderie Moderne," which had been translated by his (Mr. Hall's) employer and himself, and they carried out certain experiments, which were afterwards described in the FOUNDRY TRADE JOURNAL. One question arose out of those experiments, and that was with regard to the casting of shells. M. Ronceray, he believed, had cast shells, or had had them cast in France, the big side up. Was that correct?

M. RONCERAY said it was.

Mr. Hall said Mr. Bartlett was casting shells with the thick side up, with a feeding head on top. Was that correct?

MR. BARTLETT agreed.

MR. HALL said that during the war he had been taken to Woolwich Arsenal to see some of these shells cast. They weighed about 10 lbs., and at Woolwich Arsenal they were casting them with the heavy side up; there was about 1⅛-in. of metal on the thick side, and there was a runner all the way round about 1-16th-in. thick, with one down-stick. As soon as the shell was cool enough, they hit it, and it dropped out of the runner, but when put up for test the shells used to leak. His firm had taken on a contract for those shells. They at once commenced to cast them the thick side down, and had a 1-in. down-stick, which poured four shells. They would understand that there were four in one box, against Mr. Bartlett's six. They had the 1-in. down-stick to take all four, with a small runner in the bottom, and no riser. He was not going to say they had success every time, but under the hydraulic test they never lost more than 1 per cent., and there were never any wasters. They rammed very hard. The trouble in England seemed to be that we must not ram very hard, because if we did we should get scabs. Was it a question of the sand more than anything else? They knew the iron entered into it to some extent, but he wanted to find out what effect the sand had. He was still experimenting on these lines with different sizes of runner

Applicability to Steel.

MR. F. DARLEY (Messrs. Firth, Sheffield) said he had not had much experience with cast iron, but he was very much struck with M. Ronceray's method of slow running and cooling in order to get a solid casting, although personally he had very little faith in it. In his opinion they must have very hot metal to do that, and the hotter the metal the greater the contraction. In steel, with which he was concerned, it would be of no use at all, for the simple reason that they could not run a 1-cwt. casting with less than a 1-inch runner, and further, unless the steel were very fluid, *i.e.*, very hot, they would not get an intricate thin casting 1 in. thick and 5 ft. long with a runner of less than 1¼ in. He had also found that it was an utter impossibility to make a steel casting perfectly, where they had to feed a thick part through a thin wall. The contraction of steel was 7/32nd of an inch to a foot, whereas in the case of iron it was only 1/10th of an inch. He was rather surprised that brass and phosphor bronze was about 3/16ths. of an inch, nearly as much as steel. He had come to the meeting because it had been announced that the question of making castings without heads would be discussed, but he was afraid there was no chance of being able to make steel castings without heads, simply on account of the excessive contraction, and the difficulty of keeping the steel sufficiently fluid to run with a small runner.

Sand Experiments.

MR. E. H. BROWN said that he had been present last September at the conference of the Association Technique des Fonderie, at Liege, and he had had the pleasure of visiting both Messrs. John Cockerill's works, and also those of the Esperance Longdoz, and he would like to point out two or three fundamental factors on which their methods differed from those of the majority of foundries in England. First, with regard to Belgian sands, they were totally different from our own. They were produced from sands which were found, he believed, either on the outskirts of Belgium, or in Luxembourg, and sometimes, perhaps, in Germany, but the Belgians were producing a casting with a finer skin than we could produce, while that particular sand was far more porous. When he came back he had brought with him a box of sand from one of the foundries at Liege, passed it through a series of sieves, and compared it with an average sand in his firm's works at Newcastle. Whereas their own sand would barely pass through a 60 mesh sieve, he could pass practically the whole of the Belgian sand right through that, and about 45 per cent. of it through an 80 mesh sieve. That was considerably finer than most of them in England could use. Similar samples of sands, 3-in. square, were rammed under a Brinell testing machine, to get the same pressure on the two. He put through a constant flow of air, and for the purpose of the experiment he was using a carbon dioxide diffuser. The Belgian sand passed practically 25 per cent. more gas than the English, at the same pressure. With regard to the composition of the metal. The composition of the cylinders mentioned in the lecture was nothing like that of the cylinders he had seen made here and in Holland. He quoted an instance of some cylinders of very similar construction, which he had seen made during the five weeks he spent at a works in Amsterdam. They were making practically a similar type of casting with a head somewhere about 9 in. in height, tapering from about 3 in. at the top, to, roughly, 1¼ in. at the bottom. The metal was nearly 0.5 per cent. lower in phosphorus than that which he understood was being used in Belgium, and the sulphur was considerably higher, certainly up to 0.15 per cent. almost every time. That necessitated a manganese content of well over 0.44 per cent., otherwise they would get sulphur blowholes. The manager of this particular foundry had told him that they could cast the same cylinder in what he said was identically the same composition of metal as used in Belgium, without heads, but when they tried their own metal, which, due to the sulphur content, was considerably thicker, it was impossible.

High Temperature Tests.

There was another point, with regard to temperatures of casting. When speaking of casting with hot metal, they must remember that hot metal did not mean the same to one foundryman as to another. He was astounded in the particular foundry he had mentioned, in Holland, to see the metal they were running through a cupola with a receiver. He had never previously, in this country, seen metal anything like so hot, and it had taken him nearly nine months' experimenting to get anything like it. He had ascertained, by the use of a pyrometer, that the temperature was somewhere in the region of 1,500 deg. C. With regard to the whole of the castings cast in Belgium, there was in Belgium practically nothing else than intensely high phosphorous iron. Iron was coming from Belgium and Luxembourg containing phosphorous up to 2.6 per cent. Was that the metal which M. Ronceray was putting into some of the castings he had mentioned? Because if so, the average Englishman would not look at it.

M. RONCERAY said it was impossible.

Semi-Steel Considered.

MR. BROWN, continuing, and dealing with the question of semi-steel, said he believed it was generally accepted now that semi-steel differed from cast iron only in the very slightly lower carbon content; the diminution was in the vicinity of 0.1 per cent., and there was also a somewhat lower manganese content. If they had to have a thicker runner for the semi-steel, did not that mean that with any thick metal the same would be necessitated? During the course of the last two years he had been casting some cylinder liners for a marine engine. The sulphur content was over 0.2 per cent., and it was deliberately kept at that high value. In the past there had been an enormous amount of trouble with the porosity in the top of those cylinders, and they had had some very big heads cast on them. With a 72-in. liner it was the usual practice to cast with an 18- to 21-in. head. He illustrated his remark by means of a sketch of a half-section of the liner.

Such a casting would show a depth of anything up to 72 in., and a thickness of metal of about 1¼ to 1½ in. except in one place, where it would be about 2½ in. After a good deal of experimenting

he had found that the shorter tapered head was considerably better than a long narrow one. The runners for these liners were cast on the top of the head: there were four runners, about 1½ ins. long by, roughly, ½-in. wide. As to the sulphur content, high-sulphur metal had advantages over low-sulphur metal in some ways. In dealing with a cylinder liner they were endeavouring to obtain a casting with a hard skin, resistant to wear, and also, when dealing with superheated steam it had to stand up to a fairly high temperature and still be resistant. Sulphur hardness maintained that resistance to wear considerably better under increased temperature than silicon. The average percentage of silicon in these liners was between 0.9 and 1.2, depending actually on the size of the liner. Manganese, of course, was higher still, about 1.54. He would like to know if M. Ronceray could suggest any method of running that particular type of casting with the same composition metal, and without the enormous head, because it ran into enormous cost both in melting the metal and in cutting off the head.

Gas Engine Liners.

Mr. J. Longdon said there was in this country a good deal of practice on the lines which M. Ronceray had laid down. The difficulty was that foundrymen, and perhaps English foundrymen especially, needed more courage. As M. Ronceray had pointed out, the principle was to keep the metal entering the mould at the thinnest possible part of the casting, in order to enable all the metal in the mould to set as nearly as possible simultaneously. He did not claim that he had tried the small section runner, but he had proved the validity of the principle of putting the metal into the mould at the thinnest place, so that the metal finally reached the heavy part when it was cooler, it being the last place reached by the metal, so that there was more chance of even cooling. Some years ago he had experience of casting gas engine liners, having sections pretty much as those outlined by Mr. Brown. The weight varied from about 14 cwt. downwards, the bigger ones having a section of about 2 ins., being about 4 ft. 6 ins. long, and cast on end. There was no big head cast on the end; there was a head of about 1½ ins., but it could not be claimed that that was a feeding head. Its function, he believed, was to receive gas holes or any scum that might have arisen through the operation of casting, and he was surprised to notice that no bad results accrued, such as one might have expected. In this case there were hundreds of liners cast perfectly sound, with perhaps three small runners on the top, each about 1 in. round. Mr. Brown had referred to the difference in the metal used here and on the Continent. He had said that the Belgian metal was higher in phosphorus and lower in carbon. He (Mr. Longden) was rather of the opinion that that told in favour of M. Ronceray, because if on the Continent they could get sound castings with a lower carbon content and a higher phosphorus content, that seemed to help to prove their case. He believed he was right in saying that the phosphide eutectic was the last to set in the casting, and that the contraction was greater than that of the pure iron. Consequently, there was a greater tendency for the production of the holes. Similarly, the absence of sufficient carbon would also tend to make for increased liquid shrinkage, because if the carbon were low there was less to precipitate, and when the carbon had been precipitated it took up a larger space than when it was in its combined form, thus helping to prevent shrinkage holes. He believed there was a great field for investigation in this particular matter, and there was no doubt that it needed courage, but he was quite satisfied that a great deal was to be expected of it, and a great deal of economy would result.

Pans made without Heads.

Some time ago he was responsible for the making of a number of pans weighing about 30 cwts. each. They were 4 ft. 6 ins. in diameter and 5 ft. deep, and he was staggered when he discovered that it was necessary to make them with a machining allowance on the top flange of ½-in., and with no head. These were cast with three rectangular sectioned runners, each runner being about ½-in. by 1 in., and cast perfectly successfully, and perfectly clean on the top flange. That was something he did not expect, but it was being done, and there seemed to him to be great room for investigation.

More Successful Experiments.

Mr. Creek said he would like to give the author a word of encouragement. He had been up against something which had given him a lot of trouble; he had tried all methods, and could not get a sound casting in one particular case. After reading the article in The Foundry Trade Journal, however, it had given him an idea. He went down from a 1¾-in. runner to a ½-in. down runner, and a very much smaller runner into the work itself. The first casting was absolutely sound, and from that day to the present he had had no further trouble with this particular casting. He had tried many other types with the same sort of metal, and it had been the greatest success in the foundry that he had ever had. He was convinced that there was a very great deal in this method of running if they could only experiment a little further. So far as the runners themselves were concerned, he had not quite followed the lines which M. Ronceray had indicated. Instead of having a down runner direct into the work, he had had a down runner and a cross runner, and a smaller one underneath that leading into the work. The result was, as he had said, a perfectly sound casting, and he had produced a great many of them. So far as iron was concerned, he had not had the same success, largely because he had not had the metal as hot as had been mentioned that evening. He would continue his experiments on iron, however, and believed he would get some good results.

The Author's Reply.

M. Ronceray, replying to the discussion, dealt first with hot metal. Of course, if they were going to use small gates they would have to use hot metal, and he believed they all knew that it was absolutely necessary to use hot metal to have sound castings. If they had not hot metal they would get slag mixed with the metal, and if they had large gates the slag would get inside with the metal, so that there were many reasons for having hot metal and smaller gates. He was rather surprised to hear that there was some iron containing 2.6 per cent. phosphorus; he had never seen it, the common iron used on the Continent contains 1.6 to 0.27 per cent. phosphorus. In Belgium the phosphoric iron was made from the French ore, because they had no ore in Belgium. Discussing the casting of shells, during the war it was not a question of making shells with the phosphoric iron made in France; they obtained hematite iron from England. But that was not the best, he could assure them. Irons of different analyses behave differently, but when the castings shown were made in different shops it would be understood that the analyses were very different. Sometimes they used high phosphorus iron, sometimes low, sometimes low silicon, and sometimes low sulphur, and some of the castings he made himself with only 15 per cent. pig-iron, and with a high phosphorus content. One, he believed, contained 0.26 per cent. sulphur, so that this proves that it was possible to make castings without feeding heads with both high and low sulphur or phosphorus. It seemed to be a matter of adaptation in each case. The brass experiments gave the same results. He could not give his experience with steel, because he had had none, and he did not wish to mention anything he was not sure of. He had heard that if they wanted to get ingots with small pipes they had to resort to slow pouring, and he asked Mr. Darley whether that was so.

Mr. Darley said it was possible to make an ingot to run on somewhat similar lines from the bottom. His firm made them in their works, ingots of about 2 tons, and there was probably about 4 ins. of pipe in the top only. On the other hand, he had seen the pipe fully half the way down, but by slow running, with a smaller runner, it was possible to run steel with a pipe of only about 4 ins. His firm had a Research Department, and they continued casting ingots and other castings and indexing them, with a view to trying to get over these difficulties. He believed they had got the casting of ingots as nearly as possible with a

minimum of piping, but that was done by having a refractory top pipe. These did not act as chills, because they were put in hot.

M. Ronceray said he had no personal experience of steel, but he believed that something could be gained in this connection, by experimenting on the same lines. It was probably more difficult, because the metal solidifies more quickly; however, the results mentioned by Mr. Creek on chrome nickel steel are striking. With regard to contraction, it seemed that there had been a confusion between what he would call solid contraction and liquid contraction. If they poured metal into a casting and obtained by some way solidification of the mass as a whole, the casting would be sound, but they did not know up to now what was happening before solidification. Solid contraction had nothing to do with the piping. The moment the metal was solid there was no possibility of liquid contraction, and liquid contraction was what made piping. Replying to Mr. Hall, he said that shells had been made in many ways in France, good and bad. The regulation method before the war, was to pour with the heavy part down, and with the feeding head on the top. It was common practice, when this method was adopted, to find a hole in the thick part.

Mr. Hall said that was the way he had cast them, and they were all right, but at Woolwich the heavy side was cast up in the particular case he had mentioned.

M. Ronceray said that was right, and that his opinion was that shells could be made good either way, and had been, in fact, providing good practice was followed. There were many troubles that arose in casting, so that in experimenting they must not expect good results every time, but they must try to change only one thing at a time, in order to avoid assigning the wrong reason to a particular trouble. With regard to the sand Mr. Brown mentioned that in Belgium, France and Germany, sand was more permeable than in England, and at the same time, it was finer, and he (M. Ronceray) could not understand how that could be. Mr. Brown had said that the skin of the castings made in Belgium was smoother. The castings he had spoken about were dry sand castings, and the skin of such castings was produced by the blacking, and consequently has no relation to size of sand. Mr. Melmoth had said he had made the very same casting, *i.e.*, a cylinder liner with success with English sand and English iron. He did not think the English sand was bad, the success of the speakers in many different foundries on many different castings was clear proof of it, but if it were bad, why did not they make it good? If it were not permeable, he suggested putting some silica sand in when milling it. Referring to sulphur segregation and blow holes that Mr. Brown obtained, he thought that the reasons given were altogether wrong.

Sulphur Blow Holes.

Custer made experiments on the influence of occluded air on the soundness of castings, and he found that if, when pouring a casting, the air was trapped with the iron, blow holes were found. There was a combination of the sulphur with the oxygen of the air, producing sulphur dioxide. The same results were found when experimenting in sand and in chills. M. Ronceray again pointed out that the system which was referred to as his system was not his invention, his only aim was to try to throw light on the subject, which was of great interest. He would be proud of the fact that he had lectured to the London Branch if he had been able to interest them sufficiently for them to continue experimenting on the lines he had suggested. It was clearly proved by several experimenters who tried his suggestions, that it was possible to make, under certain conditions, castings without feeding heads, and if it were possible to make some castings, it might be that once they had found the reason for it, it would be possible to make them all in that way.

Votes of Thanks.

Mr. Melmoth proposed a vote of thanks to Mr. Ronceray for his lecture. In doing so, he stated that the subject of the lecture was of infinite interest to him and others interested in the production of steel castings. One speaker had said that he could not see this method being applied to steel, but in his (Mr. Melmoth's) opinion, that was not the attitude to take. He had been connected with the carrying out of an excessive range of experiments on the speed of running steel ingots, and although they were made in chill moulds as against sand moulds in the case of castings, yet they were run from the bottom with a small runner in proportion to the size of the ingot, and his firm had succeeded in dropping their percentage of waisters from these ingots from 25 to 30 per cent., down to 8 to 10 per cent. during the war. A previous contributor to the discussion had referred to the temperature of cast iron. He had never heard of such temperatures as 1,560 deg. C. in cast iron, and he did not see what practical purpose would be served if it were obtained. Also, according to some metallurgical opinion, excessive heat in any metal in the liquid state was liable to leave behind after ill-effects. As to the use of the optical pyrometer, he had not a half-penny worth of faith in any optical pyrometer on the market for judging the temperature of a stream of molten metal. He commented on the fact that the industrial people in this country, who, after all, did count for something, were discussing the technical and industrial problems, whilst the politicians were dealing with more or less abstract and unproductive political questions, and also on a gratifying fact, that it was one of our French allies in the recent War who was teaching them the possibility of this particular method of casting. He himself was going to try to make certain types of steel castings on the lines suggested, and believed one person had already had some success in doing so. He had the greatest pleasure in proposing the vote of thanks to M. Ronceray for his excellent lecture, and the extremely genial way in which he had dealt with the discussion.

Mr. Faulkner, seconding the vote of thanks, said he was rather proud of the fact that he had started the ball rolling. He had given a short account of M. Ronceray's work in the Foundry Trade Journal, and it gave him a feeling of satisfaction to know that one member had derived practical benefit from it.

The vote of thanks was accorded with acclamation.

M. Ronceray, in a brief reply, said he was proud to have received such a warm reception, and emphasised the importance of the exchange of ideas.

Contamination of Air with Carbon Monoxide.—Messrs. Yandell Henderson and Howard W. Haggard, of Yale University, in a contribution appearing in the "Journal of Industrial and Engineering Chemistry," draw the following conclusions from experiments in which the period of exposure was several hours. The time of exposure in hours is multiplied by the concentration of the carbon monoxide in parts per 10,000 of air. If the product equal 3, no perceptible physiological effect is noted; if it equal 6, the effect is just perceptible; if it equal 9, headache and nausea are produced; if it equal or exceed 15, conditions are dangerous to life. Exercise and physical work increase the rate of absorption of carbon monoxide from a contaminated atmosphere. Upon return to fresh air the carbon monoxide which has been absorbed by the blood is excreted through the lungs; from 30 to 60 per cent. of the absorbed carbon monoxide is excreted hourly. Carbon monoxide is the only toxic constituent of importance in the exhaust gas from gasoline. Illuminating gas and the exhaust gas from coal tar distillate contain other toxic constituents as well as carbon monoxide.

The Basset Process.—Speaking at the annual meeting of the Ougrée-Marihaye Company, M. Gustave Trasenster, chairman, mentioned the Basset process, which, he said, had already yielded satisfactory results. The production of a high temperature in a reducing atmosphere, which is the basis of this new process, represented an indisputable progress. The intentions of the directors had been to follow very closely the trials which were being continued, and to secure for the company the exclusive patent rights for Belgium, Luxemburg, and a portion of France. Under these circumstances the Company had considered it advisable to participate in the French company to the extent of 1,000,000 fcs. Among other results obtained with the new process, the speaker mentioned that it had been possible to abstract the metal from the ore, leaving only 1 per cent. of iron in the slag. Certainly the lining of the furnace was not yet what it ought to be, but patience must always be exercised in such matters. If success attended the Basset process the shareholders would have no reason to complain.

Making Castings without Feeding Heads.

By S. G. Smith.

Being interested in the above subject, dealt with by Mons. E. Ronceray, which appeared in The Foundry Trade Journal in the issue of June 1, and the writer having been asked to enlarge upon, confirm, explain, or comment upon its general application in future practice.

Having had to deal with many foundry troubles, difficulties and problems in a large variety of iron castings, it is hoped to approach this matter with an open mind. It is rather difficult to know where to commence and where to leave off. An attempt of this description must necessarily be to some extent exhaustive.

In recent articles, and others which will follow under the writer's name in The Foundry Trade Journal, the conclusion arrived at will be that the writer is a strong advocate for feeders and dross heads. Whilst admitting this when necessary, he is not unduly biased if something equally as good can be applied.

Can feeders, feeding heads and dross heads be partially or wholly dispensed with successfully with all or some iron castings? Obviously, it all depends. Starting at genesis, it is generally recognised up to and beyond the fusion temperature of cast-iron there will be to some extent a corresponding expansion in the molten mass according to the temperature reached. If that be true, it will be obvious that the higher the temperature of the molten iron when in the mould, the greater will be the liquid contraction when cooling.

It must be clearly understood that the total weight of a casting is no indication whether that casting requires feeding or not. It is quite possible that a casting weighing 50 tons may require no feeding, and will exhibit no open or porous parts, and yet a casting weighing only 50 ounces may require some precaution to make it sound.

With such a complex mixture as cast-iron, the rise and fall of the temperature from cold to fusion point, and higher to white hot, and downwards from white hot to freezing, and then to cold, many separations, constitutional and volume changes may, and do, occur.

Porosity.

There are three well-known conditions that require some precautions to overcome porosity and segregations: (1) Liquid contraction due to cooling; (2) draws due to thick and thin section of metal in close proximity; (3) where a section or area of a casting is enclosed by an outer section and is kept in a molten condition much longer than all its surrounding parts. At the moment the critical point of the phosphorus eutectic will not be considered, being an accomplice in the formation of draws and cavities.

The only way to produce a sound casting to be free from the defects just referred to is control of the temperature during and after the metal has been poured into the mould, *i.e.*, the solidifying or freezing of the metal in the mould must be uniform throughout the casting. If this can be accomplished by proper location and distribution of small runner-gates, or by the application of denseners, the result will be a uniform-texture casting throughout. But it is obvious this cannot always be obtained even with the best methods of moulding, some of which will be enumerated later.

It is a fact that much molten metal is wasted due to unnecessary risers, feeders, and possibly dross heads, but the commission of the latter sin is very rare.

Another wastage of molten iron, which is deeply rooted in some foundries, is running metal through the off risers after the mould is full. It is quite correct to do this if the mould is blowing, but it is often done from habit alone. The object is, that the metal flowing in through the mould makes for soundness, which is quite erroneous. When a mould is full of metal, nothing moves from the top surface, the flow passes through the runners and under side of the mould to the risers, following the line of least resistance. The metal on the top surface of the mould remains quite still.

Referring at Fig. 7 in Mr. Ronceray's valuable article* which perhaps should be called an hydraulic ram. It was a bold move on the part of anyone to make this casting crown upwards. The writer has made these castings lighter and heavier than this one, but of a more uniform section. The writer is inclined to criticise this design, which he thinks is bad. Why 11 13-16in. of metal on the crown when 4½in. would more than meet all requirements? More metal is wasted in this abnormal thickness than would be required for a large feeding head. Apart from the wastage of weight there is a possibility of a very open-texture metal just where it should be sound and dense. It is not remarkable that a 1¼in. round runner should pour this casting, providing the metal was very hot and fluid. The mould would fill slowly towards the finish, and if the metal was dull it would not fill up to the top of the crown.

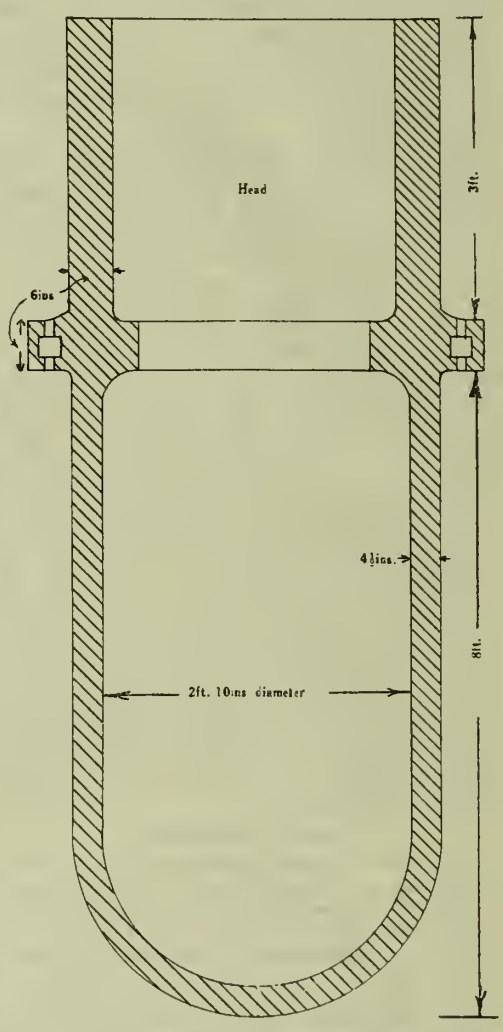


Fig. 1.—A Hydraulic Ram Cast with a Few ⅝-in. Round Runners.

So far as actual weight of the runner is concerned, it is greater than a few small round runners, say, ⅝in. dia., required to pour such a casting from the top instead of the bottom. The article states that the top of the crown came out slightly flattened. Such is to be expected with this method of moulding it, and in all probability if the top crust of the metal of the crown was broken through, open, porous cavities may be disclosed, due, of course, to liquid contraction. The fact that it was put into work without trouble is not conclusive proof of freedom from porosity on such a thick crown. A casting with a flattened crown would not pass inspection in this country, unless some exceptional guarantees were given. Here, such castings must be perfectly water-tight under pressure.

* See page 393, June 1 issue of The Foundry Trade Journal.

Hydraulic Ram Considered.

Fig. 1 of this article shows a hydraulic ram as an example of British practice. It was poured by a few ¾in. round runners on the top. The design of this should be recommended. The abnormal thickness and depth required special attention regarding both area of feeding head, also density of the iron. Referring to Figs. 3 and 4 of Mr. Ronceray's paper and to THE FOUNDRY TRADE JOURNAL of May 18, page 366, which contains a brief article by the writer on Commutator Bushes, Fig. 2 of the latter shows small centre runners through the centre core, similar to Figs. 3 and 4 in Mr. Ronceray's article, but these castings could not be produced perfectly sound and clean without the application of denseners and dross head. The other castings, including the loco cylinders, call for no immediate comment, as it is a matter of hot fluid iron.

British Experiments.

Reference is made to British experiments, but British practice for many years has been when pouring large or small engine liners, vertical cylinders, condensers, and similar castings, to have a small down runner into the bottom of the mould, in order to take a small amount of metal to prevent an excessive splashing when the small top runners are opened. A little feeding is indulged in as a precaution only. The dross head is necessary to ensure a clean top end of the casting. Very large circular castings of great depth and weight are poured with a thin flash-gate ¼in. thick; also, others are poured with a large number of very small round or flat runners distributed round the periphery. Referring to Fig. 13 of Mr. Ronceray's paper, which depicts a half-coupling, this coupling is poured the same way as the commutator bush in the writer's article just quoted. Considerable trouble has been experienced in producing these castings spotless and sound in bore and body. The way the author has overcome these troubles is shown in an article contained in the FOUNDRY TRADE JOURNAL of May 11, 1922. The writer has not tried the small centre runners in shaft couplings, which vary in weight from a few pounds to twelve cwts. If the small runner contributes to make these castings clean, sound, and free from porosity without chills or feeding, much has been accomplished. We will assume for some castings this may be possible. What is the underlying principle, or law, that is operating during pouring and solidifying? The writer's conclusions at present are that no hidden mystery is involved. The mould poured by small runners to some extent controls the temperature of the metal as the mould is being filled. A very small runner with very hot iron the mould will fill gradually. It will not fill so quickly as a similar mould would with a large runner and the metal of a lower temperature; hence, as the mould is slowly filling, the high temperature of the iron is imparted to the walls of the mould, or, to put it in another way, the walls and cores of the mould are abstracting the heat from the metal as it is filling the mould. Thus, slow filling conduces to an even and uniform temperature of the metal in the mould and contributes to bring the metal to that temperature when it is past the period of liquid contraction; in other words, the liquid shrinkage is taking place as the mould is being filled and the escape of gases is easy. Whether this is partly or wholly the true explanation or not, it is impossible to say definitely, the matter has been put in as few words as possible, and in its support there is ample proof.

Where there are several small runners the metal is being distributed in different directions, and this distribution always balances the even temperature of the metal in the mould. There will be presented in the near future in THE FOUNDRY TRADE JOURNAL a series of articles by the writer dealing with castings failing under water pressure. Under the title of Oil Cooler Castings, sketches will be given of an oil cooler cover. From this it will be clearly seen that the location of the runner in-gates was the sole cause of the porosity. When the runner-gates were altered, which ensured a better distribution of the metal in the mould, the porosity disappeared.

A simple example of how a porous place or spot can be avoided by an altered location of the in-gate will be shown later in an article under the title of Turbine Steam Chests, Fig. 3. In another article dealing with Intermediate Cylinder Heads in Vertical Gas Engines, published in July 6 issue of THE FOUNDRY TRADE JOURNAL, will be found a problem that could not be solved by small runners.

There are limitations to the universal use of small runners with high-temperature metal chiefly owing to design. A number of these are being dealt with by the writer, such as some with areas that cannot be controlled without some form of feeding or the use of denseners.

Dross heads *should not in all cases be considered as feeding heads.* With any system of small runners, precautions must be taken to avoid faint-runs, cold-laps, chilling where machined, and, above all, accumulation of oxides and dust from erosion on the upper parts of the casting as poured.

Institute of Metals.

As previously announced, the Autumn Meeting of the Institute will be held at Swansea from September 19 to 22, by the kind invitation of the Mayor of Swansea and local members of the Institute. The following is the programme:—

Tuesday, September 19.

8.0 p.m.—First Annual Lecture on subjects of practical interest to those engaged in the non-ferrous metals industry. "The Science of Human Effort (Motion Study and Vocational Training)," by Dr. R. S. Hutton, Member of Council.

Wednesday, September 20.

10.0 a.m.—General Meeting in Llewellyn Hall, Y.M.C.A. The Mayor of Swansea, Alderman William Owen, J.P., will open with a brief address. Papers will be presented and discussed.

1.0 p.m.—Members will assemble at the Hotel Metropole, Wind Street, Swansea, for luncheon, by kind invitation of the South Wales Siemens Steel Association, the Tinplate Association, the Spelter Association, the Copper Association and the Swansea Chamber of Commerce.

8.0 p.m.—Civic reception by the Mayor at the Patti Pavilion, Victoria Park, Swansea.

Thursday, September 21.

10.0 a.m.—Resumed General Meeting.

2.0 p.m.—Visits will be made to the following works:—British Mannesmann Tube Company's Works, Landore, Swansea; King's Dock Works of Messrs. Baldwins, Swansea; the Grovesend Steel and Tinplate Company's Works, Gorseinon; Steel, Tinplate and Sheet Works of Messrs. W. Gilbertson & Company, Pontardawe; Works of Messrs. Williams Foster, Pascoe Grenfell & Company, Swansea (spelter, copper and yellow metals); Messrs. Vivian & Sons' Copper Works, Hafod, Swansea; the English Crown Spelter Works, Swansea.

Friday, September 22.

10.0 a.m.—Resumed General Meeting.

1.30 p.m.—Motor tour round the Gower Peninsula, via Killay, Llanrhidian, Cheriton, Llangennith, Burry Green, Reynoldston, Stouthall, Rhossily, and return to Penrice.

New South Wales Steel Workers.—A cable from Sydney states that a conference of employers and employees to discuss the solution of the difficulties facing the reopening of the Newcastle Steel Works has proved abortive, the men insisting that any reduction in wages should be refunded from the profits of the Company.

Russian Manganese Ore for Germany.—According to reports from Kharkoff, the Concession Commission in the Ukraine recently examined various applications from foreign firms for concessions. One leading foreign firm submitted an offer for the leasing of the iron ore mines at Kholaczevskie, in the basin of the Krivoi-Rog, but the Commission refused to grant a concession on the ground that the iron ore mines can only be leased if blast furnaces are operated. The German Mining Association of Essen—the Berg und Hüttenwerke—is reported to have been more successful. After protracted negotiations with the Ukraine Commission in Berlin, the Association is said to have arranged for the annual supply of a large quantity of manganese ore in return for the delivery to the Ukraine Mining Administration of materials for the working of the mines, including cables, pumps, etc. The German Association will only accept the delivery of high-grade ore containing from 40 to 60 per cent.

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.

By Enrique Touceda (Albany, New York).

(*Continued from Page* 124.)

An Experiment with Steel.

Fig. 12 is a micrograph taken at about 4 dia. of a sample of steel containing 1 per cent. carbon. The sample was placed in a pot, together with the hard-iron castings that were about to be heat-treated, and given the same treatment as is ordinarily given the product of that company. A well-defined pearlitic-ring that is located between the

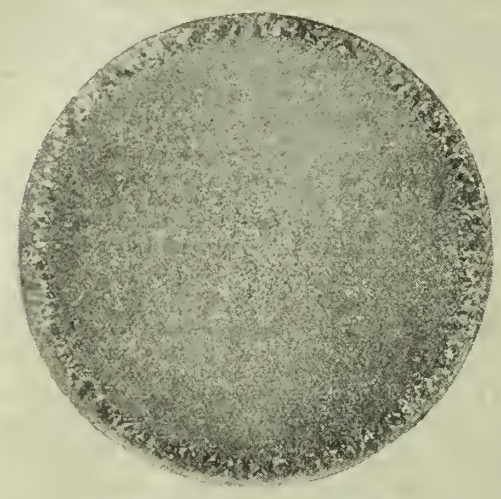


Fig. 12.—Micrograph of a 1 per cent Carbon Steel Subjected to the Same Heat Treatment as Malleable Iron.

surface border and core can be seen, exactly as happens in the case of framed malleable cast iron. There is another kind of frame in which, instead of the pearlite being at the junction of the decarbonised area and the core, it is directly at the surface. This, it is believed, results from a casing-action due to the particular pot-atmosphere existing at the time, and such as would favour the casing of the surface, which condition may be brought about in various ways, particularly when ashes that contain unconsumed coal are used for a packing. The latter condition is the worst form of frame, both from the standpoint of machinability as well as untrustworthiness under shock.

Machining Properties.

It can be stated that the ease with which malleable cast iron can be machined is its most valuable asset, and any defect in the product that operates to retard the speed with which it can be machined is fatal. The two worst defects are the framed-casting, to which reference has been made, and the shrink. Of all of the troubles to which these castings are heir, the shrink is by far the most troublesome and the hardest to combat. Whilst at one time the really-hard casting—the one that was hard throughout, due to an improper heat-treatment—was a source of constant anxiety to the manufacturer, such castings are now rarely produced. It happens, however, that silicon, sulphur, phosphorus, manganese, and carbon all can be present in ideal proportion in a hard-iron casting, and the heat-treatment conducted in an entirely efficient and normal manner, and still castings may under certain circumstances be produced that will have a steely fracture and be hard to machine. Just what operated to bring about such a condition remained a mystery to the author for a long time, owing principally to the fact that in many instances in his experience he found that when it was claimed that all details of works practice had been correctly carried out it was discovered that, unintentionally, he had been misinformed. In the particular case now referred to it was suggested by the management that if this was the author's thought he had better assume the responsibility for a trial air-furnace heat and subsequent heat-treatment. This suggestion was adopted, with the result that, in spite of all precautions, no improvement was found in the fracture. While the author had been acquainted for a long time with the effects of chromium on the structure of annealed castings, he had not suspected until this occasion that chromium was the offender, owing to the supposed rarity of this element in pig-iron in an amount that was in any way harmful; but as soon as it was ascertained that, notwithstanding the fact that every detail of the process had been safeguarded, the castings still were abnormal in fracture, the product was examined for this element, and his suspicions confirmed.

Chromium is Deleterious.

Hard-iron castings, therefore, can be produced by the presence in the mixture of very minute percentages of this element, particularly if the annealing temperature is higher than normal. Not only will less than 1/10 of 1 per cent. produce an abnormal fracture, but this will be accompanied by a phenomenon the explanation of which proved very baffling until quite recently. Some years ago one of the manufacturers was engaged in the production of some railway castings. One of the kilns was poured late in the day, and as the superintendent was anxious to ascertain the quality of the product he broke the test-lug on a number of the castings that were still quite warm, and as the fracture was normal he felt satisfied that all was well. On the following morning the railway inspectors started their examination, and not only did they find that the

Fig. 13.—A Casting Difficult to Manufacture Owing to the Varying Thicknesses of Metal.

fracture of the test-lugs was steely, but the other test-lug on the castings from which the lugs were knocked off by the superintendent on the preceding day were steely. In the case of these particular castings it appeared as if one end had been properly heat-treated but the other end not. The author was called to the plant, and as there happened to be available some test-bars from this heat that positively could be identified, these were heated to a temperature about 300 deg. Fah. (148 deg. C.), and, when broken, showed a perfectly normal fracture, but when cooled to the atmosphere and again broken the fracture was steely. From this time on a few other cases of this kind came to the author's

attention, but the cause of the phenomenon remained a mystery. Some time ago it occurred to the author that, in view of the curious effects of chromium on the fracture, possibly this element was the cause of this phenomenon also, and without entering into detail as to the complete investigation made, it can be stated that the author has been unable to bring about this condition in the absence of chromium, but that when exceedingly small percentages are present this peculiarity exists. It also appears that the evil effects of chromium are made more manifest the higher the temperature. From the foregoing it appears that at atmospheric temperature the effect of chromium is to embrittle ferrite, while at a somewhat higher temperature—say in the vicinity of 400 deg. Fah. (205 deg. C.)—the ferrite regains its ductility.

Shrink Troubles.

The casting with shrink, however, still persists, although now that the engineer-designer is co-operating with the foundry to a much greater extent than ever has obtained in the past, while everyone in the foundry connected with moulding operations are on their toes in an endeavour to minimise this trouble to the greatest possible extent, it is still with us to an alarming degree. As has been pointed out so frequently in Papers written by the author, shrink not only can prove to be the sole cause for the failure of a casting in service, but even should it occur in a part of a casting that subsequently is to be removed by machining it can cause a damage not suspected by one who is ignorant of the cause. Very early in his investigations the author discovered that, irrespective of how efficient and complete the heat-treatment of a casting might be, free-cementite invariably exists in the area occupied by a shrink,

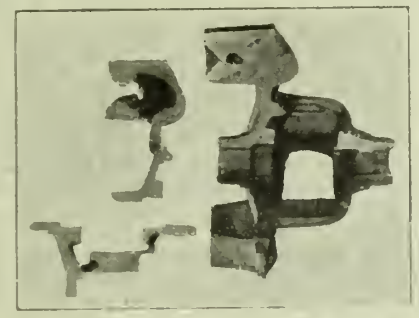


Fig. 14.—Other Sections of the Casting Shown in Fig. 13

that is, wherever a shrink occurs a hard spot will be found. Such hard spots had always been attributed to segregation, with phosphorus as the culprit. Even to-day authors of Papers talk of the liability of segregation, simply because this element is in the vicinity of 0.20 per cent., notwithstanding the fact that for the most part malleable-iron castings will not average $\frac{5}{8}$ in. in thickness of section, and solidify so quickly that opportunity for segregation is denied. While undoubtedly there may have been rare cases of phosphorus segregation, none have ever been called to the author's attention.

Anyone who has seen a Bullard Multiautomatic machine tool at work taking cuts $\frac{1}{4}$ in. thick at 150, and light finishing cuts at 250 ft. per min., machining a casting as fast as the operator can put one in place and remove another that is finished, will appreciate what it means if by chance one of these castings contains a shrink in the path of the tool. The tool set-up on one of these machines cannot be accomplished short of some three or four hours, a loss of time that will not be tolerated. In order that the difficulties of the situation may be appreciated, Fig. 13 is reproduced, showing a casting from which two sections have been cut. One cut is in line with the centre of the head, and through a section of fairly uniform thickness. In the etched section, shown above the casting, it can be seen that there is an entire absence of shrink. About 90 deg. from this another section was machined from a part of the casting whose sections are very disproportionate. The various shrink spots are plainly visible, and to those who have made a study of shrink the cause for their presence should be clear.

This particular casting could be gated and headed in almost any manner, with almost any amount of metal, with little hope for complete soundness in this particular section, while a slight thickening up of the narrow neck, just above the largest shrink and the removal of some metal from the very-heavy section to which it is attached, would enable the founder to make a solid casting, provided also some slight modification in the case of other sections was made. Fig. 11 refers to a

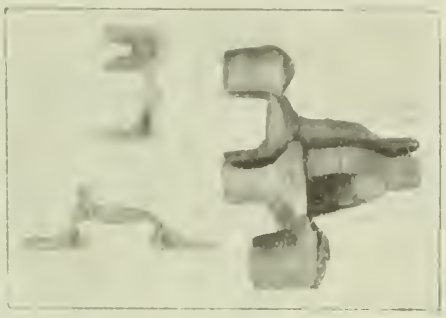


Fig. 15.—Further Illustrates the Necessity of Refusing Badly-Designed Castings by the Foundryman.

similar casting, but cut at other sections. Fig. 15 further illuminates this matter, as well as the fact that it is up to the malleable-iron founder to protect himself and his industry by refusing to make castings that are designed in a manner such as actually inhibit soundness. In Fig. 16 is shown the etched section of half of a casting fed by two risers. In this case complete soundness is apparent. In order that the case will be fully understood it should be noted that a strap was also used in this case leading from the heads to the fillet at the neck of the casting, which facilitated and made perfect the feeding at the fillet. The section from A to B is consequently thicker by the thickness of the strap at this point than would be shown in other similar sections of the casting.

For the purpose of making certain deductions in connection with an investigation that it was intended would be introduced in this Paper, and on which considerable work has been done, some bars of wrought iron and soft steel were annealed with malleable iron castings under the usual heat-treating conditions, and in the belief that, although space is lacking to include these experiments, the results of these mechanical tests may be of use to some reader of this Paper in some other connection.

It is unnecessary for the author to encumber the Paper with remarks in connection with the results; they are obvious upon inspection.

Fig. 16.—Half of Casting Fed by Two Risers and Made Sound by the Introduction of a Strap.

As inferred in the introduction of this Paper, the author has touched upon those questions concerning which he has received inquiry, while he has endeavoured also to avoid dwelling, in so far as possible, upon items that are usually found in papers covering the malleable-iron process. Pressure of work, frequent absences from the city, and other complications have prevented the taking up of a few other items that are, at least, of equal importance to any of which he has made mention, but which owing to lack of time to obtain the samples for illustrations and the making of the necessary micrographs.

In conclusion, the author would state that the future for this industry in the United States is most promising. The manufacturers are deter-

mined that they are going to get all out of the product in the way of tenacity, ductility, and shock resisting properties that investigation and improved apparatus can make possible. Any metal possessing the best machining properties of any ferrous product and having an average ultimate strength exceeding 23.6 tons per sq. in., a yield point approximating 14.75, accompanied by

Table I.—*Comparative Tests on Annealed and Unannealed Samples of Wrought Iron and Mild Steel Bars.*

Wrought Iron.

Mark	04	05	06	01	02	03
Treatment	U.	U.	U.	A.	A.	A.
Dia.	0.637	0.665	650	0.662	0.657	0.655
Actual elastic limit (tons)	4.6	4.8	4.8	3.5	3.3	3.4
Elastic limit (tons per sq. in.)	14.4	13.3	14.5	10.1	9.8	10.3
Actual ult. strength (tons)	6.7	7.3	7.0	6.4	6.2	6.2
Ult. strength (tons per sq. in.)	21.0	21.2	21.2	18.5	18.4	18.3
Elongation (on 2 in.)	38.0	39.0	39.0	43.5	40.0	42.5
Reduction of area	52.4	51.6	51.2	49.7	50.4	49.2

Mild Steel.

Mark	44	45	46	41	42	43
Treatment	U.	U.	U.	A.	A.	A.
Dia.	0.665	0.637	0.667	0.651	0.660	0.672
Area	0.347	0.319	0.349	0.333	0.342	0.354
Actual elastic limit (tons)	6.8	6.5	7.2	5.2	5.4	5.9
Elastic limit (tons per sq. in.)	19.8	20.5	20.9	15.5	15.7	16.7
Actua' ult. strength (tons)	10.1	9.4	10.2	8.6	8.8	9.6
Ult. strength (tons per sq. in.)	29.2	29.4	29.3	25.8	25.8	25.9
Elongation (on 2 in.)	41.5	41.5	42.5	43.5	43.5	43.5
Reduction of area	64.6	65.5	65.2	64.6	63.7	63.6

an elongation that easily can be made to average, day in and day out, at least 20 per cent., a figure that to-day is somewhat higher than the average of the American Malleable Castings Association's product as a whole, has a future that is very inviting. The author feels certain that, should British foundrymen enter this particular field in a large way, that Americans will be obliged to look after their laurels as far as quality is concerned. Americans would all welcome the aid and co-operation of the many noted British metallurgists. While very early in the game, and since, the author has experimented with most of the ferrous additions, no results were obtained that have given promise of an improvement of product. All the deoxidisers have been tried, and in no case has any improvement followed their use. It is the American hope that British scientists may in the near future develop some improvement in the process that will serve to make an excellent product still better.

In concluding, the author desires to again thank the Institution for their graciousness in having invited him to be with them as their guest. He also desires to thank the following manufacturers for samples of castings that have been used to illustrate this Paper and for others that were to have been used had time permitted:—Eric Malleable Iron Company, Fort Pitt Malleable Iron Company, Frazer & Jones Company, Marion Malleable Iron Works, Troy Malleable Iron Works, and York Manufacturing Company.

Production of Foundry Coke from Non-Coking Coals.*

By Dr. M. Dolch.

Various attempts have been made at different times to obtain a satisfactory foundry coke from non-coking coals, among the most important of these being the tests carried out in the United States with "anthracoal" (made with coking anthracite fines with coal-tar pitch). The author is of opinion that only by thoroughly investigating the several reactions that take place when coking coal will it be possible to arrive at a satisfactory solution. A German investigator, Dr. Lierg, recently published an article on this subject of reactions, his consideration being based on the attempt to give non-coking coals the necessary coking capacity by the addition of certain percentages of coal-tar pitch. The trouble when adding pitch for the purpose is that the constituents which go to flux the coal and make it coke escape before the coking temperature of the coal is attained in the coke oven or the retort. This difficulty makes the American process expensive, besides causing a considerable amount of incrustation in the retorts. The present author is of opinion that the binding effect of pitch can be considerably increased if the pitch is added in the dissolved state. Small-scale experiments carried out in this direction, however, cannot be repeated directly on a large scale, because in the latter case the temperature rise is much slower, so that, when the coking temperature is reached, a portion of the cementing medium has distilled out, and is therefore ineffective for the purpose for which it is added. There is no doubt that certain of the bitumens or bituminous substances of high melting point do give a certain facility of coking to non-coking coals.

Tests carried out by the present author and Dr. Lierg proved that it is not only possible to isolate the pitch substances of high melting point from those of low melting point, but also to produce such substances in pitch itself, and consequently to obtain the required products from a substance which is available in practically unlimited quantities. The initial substance used in the experiments was hard coal-tar pitch, this being first of all dissolved in a definite proportion in pure benzene. By filtering the solution and evaporating, there remains a pitch free from any substance insoluble in benzene. This was used as the basis of further tests. By blowing air into this material in the water-bath the desired result was obtained. On taking the pitch so treated and dissolving it in exactly the same quantity of benzene it was found that a portion of the pitch had become an insoluble brown powder on the filter paper. On investigating this insoluble bitumen, and testing its effect as regards increasing the coking capacity of non-caking coal, it was found to behave in exactly the same way as a substance of high melting point obtained by extraction from the coal itself, and also from pitch. The carrying out industrially of this method would naturally depend upon whether it was possible to effect polymerisation on a large scale. To discover the possibility of this, the test was repeated as above, and it was found possible to repeat the process seven times, the residue remaining after "blowing" the pitch being dissolved again in benzene, the insoluble residue filtered, the remaining solution evaporated again, and the pitch "blown" once more. After the seven blowing operations about 90 per cent. of the pitch used at the start had passed into the insoluble form.

From considerations which the author advances, the substances of high melting point would seem to be secondary products of dissociation of pitch produced by the "blowing." The author therefore assumes from repeated tests that the polymerisation of a portion of the pitch is accompanied by its fractionation.

In conclusion, the author considers the possibility of deriving these products from the coal itself, also the nature of certain coking and non-coking coals. The process he is inclined to regard as physical rather than purely chemical, and he states that the properties mentioned may be inherent in certain forms of coal obtained from different geological strata.

The experiments so far carried out show, at any rate, the possibility of using some such process in order to make non-coking coals capable of coking, and oven from extracting from the non-coking coals themselves the substances required in order to make them produce a good coke.

* "Glückauf."

Electricity at the British Empire Exhibition, 1924.—The British Electrical and Allied Manufacturers' Association (36 and 38, Kingsway, London, W.C.2) have issued a pamphlet entitled "Electrical and Allied Engineering at the British Empire Exhibition, 1924," explaining what the Exhibition means to Imperial British industry and trade.

British Columbia's Steel Scheme.—A cable from Vancouver states that the Provincial Government will introduce in the autumn Session a Bill to provide a guarantee of $4,000,000 (about £880,000) for the Coast Range Steel Company's bonds for the purpose of establishing the steel industry in British Columbia. The Dominion Government is being asked to guarantee another $4,000,000.

The Development and Manufacture of High-Tenacity Brass and Bronze.

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from Page* 121.)

Impurities.

The question of impurities in brass of any kind is problematic. The difficulty is to differentiate between impurities that are harmful and those that are not. Lead, whilst commonly responsible for low-test results, local weaknesses in castings, forgings and stampings due to segregation, patchy appearance of castings and the like, is actually an asset in quantities up to 0.70 per cent., if homogeneously distributed, both cheapening cost and facilitating machining without affecting the physical properties. On the other hand, Sn., Al., Fe., Ni., V. and such special elements of proved value may come under the heading of "harmful impurities," if present unintentionally or incorrectly alloyed. As., Cd., Sb., and Bi. are amongst the most dangerous impurities in brass, but whilst small quantities of these might be harmful singly, they may not be objectionable if in combination with each other or with some other particular element.

Possibly the most objectionable impurity in high-strength brass and one that does not receive the attention it deserves, is Si. In no instance has the author found its presence advantageous—small quantities being conducive to brittleness without conferring any other useful property to compensate for the loss in ductility. It is one of the principal hardeners, and is twice as effective as Al. and ten times that of Zn., weight for weight.

The real value of Si. to the brass founder is as a deoxidant, and should be used in the same way as Mg. and P., which are amongst the best scavengers, but harmful if any remains in the finished alloy. Mg. exerts a similar effect to Si. P., if present in quantities of over 0.15 per cent., causes both blistering and honeycombing.

CO., SO_2, N., H., and various hydrocarbon gases, are present in all brass, sound and unsound. If during melting the charge is overheated or directly contaminated with obnoxious fumes, they are absorbed in excessive quantities, and their evolution on cooling is the principal cause of blowholes in castings.

Problems of Manufacture.

On discussing the manufacture of manganese bronze with the owner of a large brass foundry, he expressed the opinion that the difficulties were such that he did not consider them commercial alloys. This appears to be common experience, yet they are not impossible alloys if the precautions outlined in the first section of this Paper are followed. Certainly Al., Fe., Mn., Ni. and such metals are amongst the most dangerous materials in the brass foundry, and require both a metallurgical knowledge and consummate care in handling, but, apart from these, the actual difficulties of manufacture are no greater than those of ordinary brass.

Melting.—Briefly stated, the principal features to be observed in melting are:—(1) Preparation of suitable stock alloys for the introduction of the more refractory metals. (2) Correct selection of materials; calculating the mixtures from their actual chemical composition, and allowing for melting losses. (3) Carefully weighing out the necessary additions and charging in their correct order. (4) Avoid the use of scrap of doubtful chemical composition, particularly with regard to Fe., Al., Sn., Si. and dross contamination. (5) Melt as rapidly as possible in a neutral or slightly reducing atmosphere, but never superheat more than 20 per cent. of the actual melting temperature and control pyrometrically. (6) Avoid retention in the furnace for long periods after correctly melting. Where this is impossible, carefully control the temperature, cover with a protecting slag, and adjust for Zn. losses. (7) Mix well, but do not oxidise in so doing. (8) Deoxidise with a little phosphor-copper or phosphor-tin just before casting if the alloy contains Mn.; if Mn. is absent, as in the Ni.-Al.-Fe.-brasses, a little copper-manganese is beneficial both as a deoxidant and desulphuriser. (9) Avoid as far as possible contamination with slag in the ladle.

Crucible Melting.—If melted in the crucible, no difficulties present themselves other than those mentioned in the preparation of the development alloys. Despite the high cost in fuel and crucibles, this is still the most commonly used method, and is favoured because of the flexibility of temperature control, the ease of mixing, low melting losses and protection from dirt and obnoxious gases during melting.

At the same time, the open-hearth furnace is of particular value for the manufacture of large castings. Where first cost permits, the gas producer regenerator or recuperator type is recommended. It is flexible, economical and efficient. The coal-fired open-hearth furnace is commonly installed, but it is costly to run, and both the temperature and composition of the metal are difficult of control.

The thermal efficiency of the oil-fired open-hearth furnace works out roughly at about twice that of the ordinary coal-fired air-furnace. Lighters-up, furnacemen, and ash-removers are dispensed with, and flexibility of control of the furnace is a decided advantage. The fierceness of the oil flame is a disadvantage to this furnace, although by the aid of a burner, permitting of accurate regulation of both oil and air and by the used of a good fuel-oil, no trouble should be encountered in this direction.

The common objection to all open-hearth furnaces for the melting of special brasses is the large surface of metal exposed to the furnace gases, which, if oxidising or sulphurous in nature, are injurious. A few logs of hardwood charged during the melting-down period, an occasional shovelful of hardwood charcoal or anthracite coal, and a suitable protecting flux remedy this. The choice of the flux is extensive, but either of the following may be recommended:—(1) Equal parts by weight of plaster of paris and fluorspar; (2) soda ash, 30; fine silica sand, 20; fluorspar, 33; and borax, 17 per cent. by weight. These should be ground down, 2 to 3 per cent. by weight of the charge being sufficient. Melting should not be forced.

Electric Furnace.—This is the ideal melting furnace so far as quality of metal is concerned. With either the direct or indirect resistance or induction furnace melting is almost automatic, Zn. losses and impurity contamination are reduced to a minimum, and melting temperature under perfect control. Unfortunately, electricity is not a commercial fuel in this country, and the crucible resistance furnace—an ideal brass melting furnace—on trial under actual foundry conditions, proved to be costly in both current and crucibles. The induction furnace is flexible, but costly in fuel consumption. The indirect-arc, rocking-furnace appears to be a promising development, but having no working experience, the author can express no opinion.

Scrap.—For high-grade castings only approved scrap should be used. Where the chemical composition is uncertain, and when the metal is either of undesirable form or dirty, it should be run down into pigs. In the recovery of brass swarf, all scrap contaminated with white metal and excessive oxide should be thrown on one side, and the remainder passed through a magnetic separator. If briquetting is possible, 2 to 3 per cent. of borax or plaster of paris should be mixed in and sprinkled with water immediately before pressing. If this procedure is not possible, the swarf should be mixed with 3 to 5 per cent. plaster of paris or 5 per cent. of the No. 2 flux mixture given above, together with a little coal dust, and melting with a reducing flame.

The objection to the use of fluxes in the open-hearth furnace lined with ganister is the accumulation of slag which banks up the hearth and puts the furnace out of commission. To avoid this, the bottom should be flowed with a suitable flux such as plaster of paris or this material in conjunction with soda ash and fluor spar, according to the nature of the slag.

Removal of Iron.—Iron, existing as an Fe.-rich constituent of lower density than brass, rises to the surface on melting. By using a siliceous slag and an oxidising atmosphere, much of the iron may be oxidised out into the slag as a ferrous silicate.

Removal of Sulphur.—Some protection against this obnoxious impurity is afforded by the introduction of a little NaCl, into the melt. This should be worked in from the bottom, followed by a little Cu.-Mn., which procedure is a safeguard against gas-holes and porosity, common defects of castings made from scrap. With correctly refined scrap of desired composition up to 60 per cent. may be used with safety. Of the ordinary domestic scrap, such as gits, risers and clean overflow metal, no more than 30 per cent. is recommended. All scrap should be tested carefully for Si., As., Sn., and Sb.

Casting.

Ingots and Chill Castings.—Ingot moulds should be short and squat rather than long and thin, and slightly wider at the top than at the bottom. Both ingot moulds and chill moulds should be preheated to a temperature of 37 to 93 deg. C., cleaned with a steel brush and dressed with an organic material. When a clean, smooth skin is desired, a simple tallow or heavy mineral oil dressing is recommended. For general work, a facing of tar followed by a second one consisting of a mixture of dark cylinder-oil of over 205 deg. C. flash point, mixed with powdered charcoal and followed by a dusting of fine charcoal. Polishing-in of black-lead or smoking with burning resin or creosote oil is quite satisfactory for ingots, and does not belch forth the obnoxious fumes and flames common to oil and tar-dressings.

Speaking generally, 10 per cent. superheat is a satisfactory casting temperature, although for heavy ingots it may be reduced to 7 per cent. Top-pouring through a specially prepared runner basin is recommended. A refractory head is an advantage, but not essential, if the caster understands his job. For the manufacture of high-class stampings or sheet, machining the skin of the ingot or slab may be found advantageous.

Green Sand, Dry Sand, and Loam Castings.—The success in the manufacture of any brass casting mainly depends upon the selection of the correct moulding materials and the individual skill of the moulder. There is not time here to detail the preparation of moulding sands and loam, so the problems dealing with such must be reserved for a later date. Briefly stated, the technical properties to be controlled in a moulding sand are:—(1) Bond, *i.e.*, strength; (2) grain size or texture; (3) heat conductivity; (4) refractoriness; (5) permeability and longevity.

Having once established a means to control and standardise the mixtures for the various classes of work, many of the moulder's problems automatically disappear, and the economies effected soon compensate for the initial expenditure necessary. In green sand moulding alone the preparation of synthetic-moulding sand has effected a saving in moulding costs of not less than 20 per cent.

Conditions governing the choice of mould-green, dry sand or loam, and the general principles of moulding, are very similar to those of ordinary brass-castings, and call for no special comment.

Gating and Feeding.—Without doubt this is the cardinal problem of the moulder. Wrong gating and feeding are responsible for more defective work than any other operation in the foundry. They call for an elementary knowledge of both physics and mechanics, together with practical experience—without which it is impossible to make a commercial casting, *i.e.*, a good quality casting for the minimum expenditure of time, labour and materials. It is folly to attempt to lay down hard and fast rules, as almost every class of casting presents its own difficulties. The principal points to be observed in gating and the fixing of risers are:—

Gits.—(1) *To fill the mould so that the stream of metal is continuous and not broken up on entering the mould.* Wherever possible, run from the bottom or on the level with a good head. This is particularly important in brasses containing aluminium and manganese, which must be cast under the exclusion of air as far as possible. (2) To prevent dross from entering the mould. For flat, circular castings a whirl gate is preferable; for cylinders and the like run from the bottom by means of a series of tangentially cut "V" shaped jets, and for general castings, an ordinary skim gate. (3) To arrange for a straight run of the metal and to avoid direct contacting on delicate cores or projections in the mould. Avoid sharp angles at turning points.

Feeding.—(1) Mould in such a way that the heavy sections are placed in the upper part of the mould. (2) Connect the heavy sections, which are shut off from the lighter sections, to a good feeding riser, by a section of increasing dimensions. (3) Use chills on the thicker sections to equalise the rate of cooling. (4) Use risers or flows of conical form appreciably larger at the top than the thickest section of the job. (5) Place risers at the highest point of the castings and directly above the thickest sections. (6) It is false economy to cut down the number or size of the risers and small dummy risers should be placed where dirt is likely to be trapped. (7) Risers should be filled preferably with hot metal from another ladle or crucible. (8) Where rod feeding is necessary, choose the right section of rod and pre-heat before immersing.

Pouring Dishes.—These should be designed so that bottom pouring is always obtained, so preventing the entrance of scum into the mould. To this end, deep pouring dishes and cast-iron plugs are an advantage. For large important castings, the pouring dishes should hold at least $\frac{1}{3}$ the weight of the casting.

Pouring.—In the final operation of pouring, the first and foremost factor controlling the production of sound castings is the selection of the correct casting temperature from the dimensions and requirements of the job. Never cast with under 6 per cent. superheat nor over 15 per cent.

The casting temperature of these alloys usually range between 930 deg. C. to 1,030 deg. C., according to the chemical composition, etc. The actual casting temperature, however, is best found from Fig. 1, adding the desired percentage of superheat to the melting-point figure. For actual foundry use, small quantities of special metals (under 0.5 per cent.) need not be taken into account. Exceeding this amount, they should be calculated back into either their Cu or Zn equivalents. When the alloy is complex an actual freezing temperature determination is the only satisfactory method. If cast with metal on the cold side, short runs, low strength, brittleness, drawing, blowholes, cracks and mechanically contaminated oxide are the principal defects encountered. If too hot, honeycombing, wrong composition, poor physical tests, weak crystal zones and segregation. Whilst absolute control of casting temperature is appreciated by all founders, there are few who actually measure it from day to day. This may be attributed to the want of a reliable instrument. To anyone interested in foundry pyrometers, the author would refer them to a Paper given by J. Arnott (Proceedings B.F.A., August, 1920), and a Paper read to the Newcastle Section of the Institute, March, 1922.

In concluding, the author desires to express his thanks to the directors of Sir W. G. Armstrong, Whitworth & Company, Limited, for their permission to publish this Paper, particularly to Sir G. Hadcock, F.R.S.; also to recognise the invaluable assistance and advice rendered by Mr. Homfrey, chief of the Brass Department, and to thank Mr. Adam for his kind indulgence, encouragement and keen interest evinced throughout.

The directors of the Clyde Valley Electrical Power Company, Limited, have declared an interim dividend on the ordinary shares of 2½ per cent. (actual).

Some Notes on Belgian Foundry Practice.

Our representative recently had the opportunity of visiting some of the larger foundries in the Liège district, and was impressed with the efforts made to effect economies and to produce sound castings.

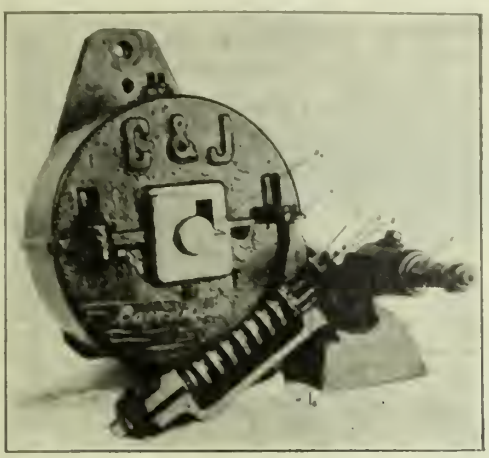


Fig. 1.—A Ladle Gear Case Cut Open to Show its Internal Mechanism.

In the foundries of Esperance-Longdoz, of which Mr. Varlet is the manager, a considerable economy was effected in the manufacture of ingot moulds, as the heat evolved by the cooling castings was employed to dry the moulds for the next batch. Thus, the drying of the ingot-mould moulds was effected for a mere depreciation price of a simple installation. In the same foundry, some of the hot gases leaving the large drying stove are utilised to dry all the moulds and cores for the brass foundry which is situated on a floor above, the stove of this department being built over a portion of the mould-drying oven.

The moulding times outlined in Mr. Varlet's paper on Loam Moulding in the Province of Liège were confirmed by our representative, and were even thought to be very conservative estimates. There appears to be much attention given to the question of pouring speeds and entrained slag, with which questions one naturally associates ladle design. In the Cockerill foundries our representative noted a bottom-pouring ladle being used for cast-iron, a loam stopper being used instead of the usual fire-brick variety. This, however, was only being conducted on an experimental scale. The ladle, however, which found most favour is one manufactured by Mons. A. Collin, of 60, Rue des Champs du Mont, Ougrée-Liège. In this type of ladle the designer has installed roller and ball bearings running in oil. Now this necessitates that the bearings,

Fig. 2.—A Modified Ladle Gear Case for Use with Large Ladles.

and especially the oil, should be kept cool, to prevent seizing in the former case and carbonisation in the latter. The method adopted has been to incorporate an air cushion in between the ladle shell and the gear-box. A gear-box, cut open, is shown in Fig. 1, from which it will be noticed that a gear-wheel (a) is attachd to the axle of the trunnion (b), which is actuated by a worm (c). This is geared up by means of the pinions (d) and (e) to the turning wheel spindle (f). The worm runs in roller bearings (g) and the ball bearings (h). The whole is totally enclosed and runs in a good-quality machinery oil-bath. The inventor claims that all torsional motions are taken up by the sliding cover. The object of placing the worm at the angle shown is to facilitate lubrication. For the larger ladles, two worms are used as shown in Fig. 2. The special problem of a geared foundry ladle is that it must run smoothly amidst dirt and heat. Obviously the enclosing in an oil-bath has eliminated the dirt question, but to have gearing running in oil a few inches from liquid metal required some further consideration. Primarily, most ladles being slightly conical in the vertical sense, are provided with tightly-fitting belts of similar form. Now the expansion of such a belt would cause the axis of the trunnion to be deformed, and the gearing to seize or work stiffly at its normal working temperature, though it may turn freely when cold! Mr. Collin therefore incorporated a true cylinder for the belt, and separated it from the body of the ladle by an air-gap as is shown in Fig. 3, thus eliminating the dual trouble of unequal expansion and the overheating of the gearing. Our representative saw a ladle of this type at work in the Cockerill foundries, and

Fig. 3.—A Ladle of 20 Tons Capacity. It is Provided with an Air-cooled Cylindrical Belt for Preventing the Overheating of the Gears and Oil Bath.

was impressed with the ease with which it could be manœuvred. The turning wheel is quickly detachable and the mechanism for locking the ladle in the vertical position is a neat automatic device showing much advantage over the fork usually employed. The stream could be regulated with the ease of a water tap, the absence of back lash being particularly noticeable. The system has been covered by patents throughout the world, the British specification being numbered 175,234.

Although the system has only been on the market a very short time, about 100 have already been sold, including three for the Llanelly Foundry Company.

Another innovation noticed in the Cockerill foundries was an oil-fired cupola. This was said to be a distinct technical success, but it had not been installed sufficiently long to say definitely whether it showed sufficient economies to be a commercial proposition.

Mr. James Walton, M.P., commenting on the Amending Bill to the Trade Unions Act, which passed its second reading on May 19 by a substantial majority, remarks that if we have arrived at a time when trade unions attempt to bind their members in political matters, it obviously becomes necessary to adopt means whereby political freedom can be obtained and maintained. This can and ought to be done without the slightest desire or necessity to injure or smash trade unions in the process.

Trade Talk.

Crossley, Jacob & Gee, Limited, have removed to 8, Lambeth Palace Road, London, S.E.

Mr. Leonard Railton has removed his offices to 1, Dowlais Chambers, Bute Docks, Cardiff.

Boucher & Company, engineers, etc., have established a branch at Green Street, Kidderminster.

Ewart Wells & Company, steelworks' engineers, have removed to 62, Holborn Viaduct, London, E.C.

The British and Foreign Metal and Chemical Company, Limited, have removed to 9, New Broad Street, E.C.2.

Wakelins, Engineers, Limited, have acquired the business of the Snercold Engineering Company, Limited, Hampton Wick, Middlesex.

At the meeting of representatives of the Welsh Siemens Steel Association and the A.E.U., under the chairmanship of Mr. George Rowe, to deal with a request for improved conditions, after a discussion an arrangement was effected.

Lithgows, Limited, of Port-Glasgow, intimate that they are prepared to lay down four large cargo steamers in their yards if their workmen will accept pre-war rates of wages, plus any bonuses and advantages to which they and other workers may be entitled.

Meldrums, Limited, Timperley, near Manchester, have taken orders during June for fuel economy apparatus as follows:—17 orders for forced draught furnaces, including collieries, gasworks and engineering firms; one order for stokers, and five orders for destructors.

The South Wales Joint Steel Board met at Swansea last week, when a wages agreement was entered into for the next three months. A graduated scale was agreed to, under which the lowest paid men will receive a bonus of 40 per cent. and other employés lesser amounts.

In consequence of the slightly reduced costs of production, Henry Wiggin & Company, Limited, of Birmingham, announce reductions in the prices of their "Ferry" resistance wires, and "Glowray," "Redray" and "Brightray" nickel chromes for cooking and heating apparatus.

Palmers Shipbuilding & Iron Company, Limited, of Jarrow, have secured a contract for the building of a special type of cargo vessel, together with the twin-screw engines, with passenger accommodation, of 7,000 tons deadweight, for London owners. The firm have also secured orders for machinery for two oil tankers to be built on the Wear.

As the outcome of a visit paid to the site of the British Empire Exhibition at Wembley Park by a party including many of its leading members, a movement was set on foot at Lloyd's, which has resulted in the munificent contribution of £100,000 to the Guarantee Fund of the Exhibition, which now amounts to more than £1,150,000, and will, it is hoped, reach £2,000,000.

John G. Kincaid & Company, Limited, Greenock, have secured an order to supply a set of six-cylinder Burmeister and Wain-Harland and Wolff type of Diesel engines capable of developing 1,350 b.h.p. for a new vessel to be built on the Clyde for British owners. They have also secured an order for another set capable of developing 1,900 b.h.p. This latter set is for a leading firm of Spanish shipowners.

The monthly ascertainments, under the sliding scale by which the wages of blastfurnacemen in Cumberland and North Lancashire are regulated, shows that the average selling price of West Coast Bessemer mixed numbers for July was £4 18s. 8d. per ton, or a reduction of 2s. 9d. per ton compared with June. The wages of blastfurnacemen in West Cumberland and North Lancashire are accordingly reduced by 3½ per cent. to 35¾ per cent. above standard.

The proposals for the closer co-operation amongst the leading engineering institutions have now received the approval of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers. An Engineering Joint Council, composed of representatives of these bodies, has been formed. Among the objects of the Joint Council will be the improvement of the status of engineers, securing the better utilisation of their services in the country's interests, the appointment of properly qualified individuals to responsible engineering positions, and the prevention of unnecessary duplication of activities.

Australia and Germany.—A cable from Melbourne states that Australia has officially resumed trading with Germany, but the proclamation prohibiting the entry of goods from ex-enemy countries without the consent of the Minister of Customs will not be revoked at present.

Company News.

Astro Electric, Limited, Carlton House, Lower Regent Street, London, S.W.18.—Capital £20,000 in 15,000 9 per cent. cumulative participating preference shares of £1 and 100,000 ordinary of 1s.

Austin, McGillivray & Company, Limited, Falcon Steel and File Works, Napier Street, Sheffield.—Capital £5,000 in £1 shares, to acquire the business carried on by Austin McGillivray & Company, manufacturers of and dealers in iron, steel and metals, files, forgings, etc. Directors: E. N. Gamble and G. L. Roberts.

Britannia Foundry Company, Limited, Coventry.—Capital £10,000, in £1 shares; to acquire the business formerly carried on by the late A. P. Smith as the Britannia Foundry Company, and to adopt an agreement with P. G. Loveitt.

Butterworth & Company (Glasgow), Limited.—Capital £2,500 in £1 shares. Electrical engineers.

Consolidated Electrical Company, Limited.—Net profit, £3,476; brought forward, £1,015; available, £4,491; dividend, 2 per cent.; carried forward, £1,381.

Controla Engineering Company, Limited, International Exchange, Birmingham.—Capital £1,750 in £1 shares; to acquire the business carried on by Controla Engineering Company (in liquidation).

Irvine's Shipbuilding and Dry Docks Company, Limited.—Profit, £100,764; brought forward, £13,687; available, £114,451; amortisation on leasehold buildings and depreciation, £9,996; income-tax, corporation tax and directors' fees, £39,303; balance, £65,152; dividend on preference, £24,000; carried forward, £41,152.

Killamarsh Steel & Tool Works, Limited, Sheffield.—Capital £1,000.

Knighton Electric Supply Company, Limited, 6, Broad Street, Knighton, Radnor.—Capital £6,000 in £1 shares.

Milners' Safe Company, Limited.—Dividend 10 per cent. per annum, less tax, for year.

Motors, Machinery & Metals, Limited, Chiswick Park Works, Kent Road, Acton Green, W.—Capital £5,000 in £1 shares.

Pickvance, Limited, 41a, Regent Street, Wrexham.—Capital £5,000 in 3,000 ordinary and 2,000 preferred shares of £1. Engineers.

E. Pulbrook & Company, Limited, 52, Leadenhall Street, London, E.C.—Capital £5,000 in £1 shares. Engineers.

Richard M. Lord, Limited, 45, Cherry Street, Wolverhampton.—Capital £1,000 in £1 shares; to adopt an agreement with F. C. French, and to carry on the business of safe makers, founders, etc.

Spauls, Limited, Castle Hill, Norwich.—Capital £6,000 in 5,000 5½ per cent. cumulative preference and 1,000 ordinary shares of £1. Engineers.

George F. Sugden & Company, Limited, 9, Albert Square, Manchester.—Capital £5,000 in £1 shares. Engineers.

Tilly & Brown, Limited, 7, Castle Street, Farnham.—Capital £20,000 in £1 shares. Tool makers.

Turnbull & Company (Metals), Limited, 2, St. James's Street, Derby.—Capital £1,000. Metal merchants. Directors: J. Turnbull and F. E. Tapping.

H. G. L. Young, Limited, 1a, Upper Hollingdean Road, Brighton.—Capital £2,000 in £10 shares. Engineers, etc. Directors: H. G. L. Young (managing) and H. T. Bailey.

Westminster Electric Supply Corporation, Limited.—Interim dividend, 9 per cent. per annum.

W. T. Henley's Telegraph Works Company, Limited.—Interim ordinary dividend, 5 per cent.

Wilson Hartnell (Installations), Limited, New Station Street, Leeds.—Capital £100 in 1s. shares. Electricians, mechanical and electrical engineers, etc. Directors: R. D. Fairclough and W. D. Oddy.

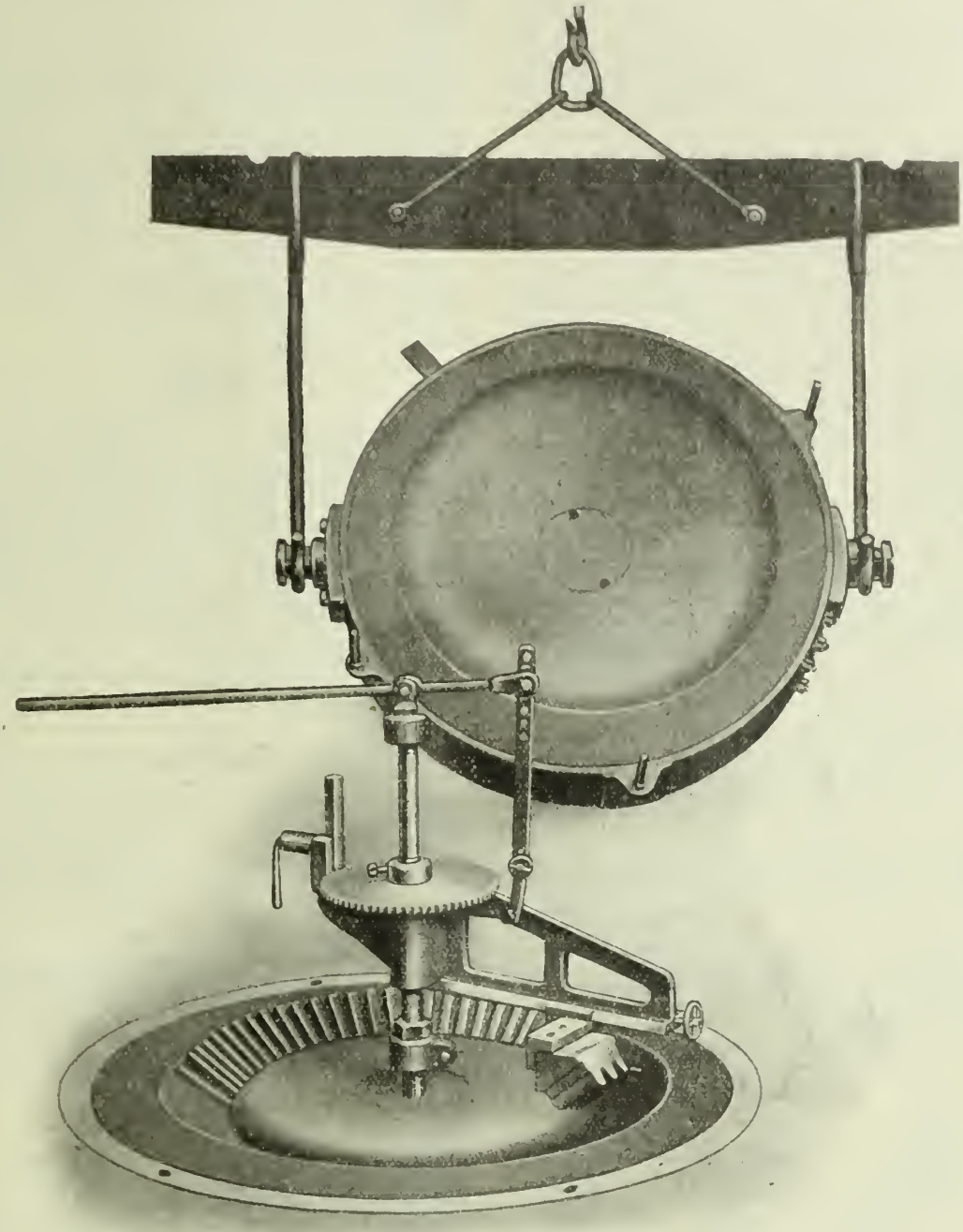
Deaths.

Mr. H. G. Walker died last week at Ednam House, Dudley, in his eighty-seventh year. The deceased, who took a very prominent part in the public life of Dudley, was the son of Mr. Henry Walker, of Netherton. He founded the firm of Walker Brothers, galvanisers and constructional engineers, of Wales.

Mr. J. B. Tompkin, of Brooklyn, Clarkgrove Road, Sheffield, has died suddenly at the age of 75 years. He had been in failng health for some time. Mr. Tompkin was the governing director of Flockton, Tompkin & Company, Limited, Newhill Steel Works, Sheffield, and much of the success of the firm had been due to the business ability of Mr. Tompkin, who was held in high esteem by all the staff, as well as by a large circle of friends.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

The month of August, in the most active times, is always regarded as a quiet period in the pig-iron trade, and on this occasion has so far upheld the tradition, market movements having practically ceased with but very faint prospects of an early development in the opposite direction. In South Staffordshire, though the usual weekly meeting at Birmingham was held, business was virtually at a standstill, consumers showing little disposition to buy, while, on the other hand, makers were not pressing sales in a weak market. The demand for foundry iron anticipated in this district, has proved disappointing, the expansion of trade hoped for following the end of the lock out not having materialised. There is, however, a somewhat improved market for forge iron, which it is expected will expedite an increased production before the autumn. On Tees-side, home demand for Cleveland iron has not yet recovered from the holiday idleness, with business still on a limited scale, conditions considered likely to obtain during the current month. The depression has been accentuated of late by the collapse of the German exchange, and its consequent effect upon other Continental money markets, with the result that Belgium has again become a competitive factor in the home trade. Some compensation may be admitted in the shape of a heavy volume of inquiry from the United States, which, during the continuation of the miner's strike has become a substantial purchaser of Cleveland iron. This movement may, however, be only of temporary duration, and Cleveland pig-iron makers are quite alive to the inadvisability of undertaking extensive contracts subject to the termination of the strikes across Atlantic. Considering the recently conceded freedom of markets, prices for Cleveland iron retain remarkable steadiness, No. 1 foundry still commanding 95s. per ton, with No. 3 G.M.B. on offer at 97s. per ton, and lower grades quoted respectively at round about 85s. for No. 4 foundry, 83s. for No. 4 forge, and 80s. for mottled and white.

In the East Coast hematite market business continues quiet, though a partial revival of the steel industry is expected to have results favourable to an early expansion of demand. There is now, it will be noted, very little difference in the prices quoted for mixed numbers whether for home consumption or for shipment abroad, buyers in the first-named category being in a position to purchase at 90s., with an additional premium of 6d. for No. 1 quality. These favourable terms are attracting more attention from the South Wales steel makers, while a few parcels are also going for shipment to Italy. In the north-west area there are heavy stocks of hematite accumulated to the extent of between 60,000 and 70,000 tons, which makers are anxious to dispose of, but even with this large quantity on hand there is little pressure to sell below the current rate of 105s. for Bessemer mixed numbers.

Finished Iron.

Movements in all sections of the finished iron trade this week have been entirely dominated by holiday influences, and where markets have been held there has been a complete absence of any developments likely to affect future business prospects. Manufacturers, with very few exceptions, have suspended operations for the annual vacation, and meantime prices for finished material have been left unchanged. A general impression, however, prevails that the downward tendency is only temporarily checked, and that on the resumption of more active conditions, the levelling down process will make further progress, the recent reduction in labour and rail freights costs encouraging buyers to anticipate some movement in that direction. Consequently pressure is being exerted to exact more favourable terms from sellers, and with order books as a rule in a depleted condition, it appears as though drastic revision of current quotations for all classes of finished material must be regarded as inevitable in the near future. For the present, therefore, prices remain stationary, but as far as firmness is concerned this qualification only applies in the case of marked bars, for which there is perhaps a slightly better demand than in the case of the commoner grades of iron, in which Continental competition continues as an active factor in controlling home quotations.

Steel.

On all sides there are at last welcome signs of a gradual revival of buying interest in steel and its products, accelerated probably by the restoration of free trade conditions in connection with the home markets by the recent decision of the Associated Makers, who have now abandoned the fixed minimum price schedule, which will mean, of course, an immediate readjustment of prices on a lower scale. So far as can at present be ascertained, this will mainly apply in the case of sections which, it appears, are now quoted at a maximum of £9. No corresponding reduction in the item of extras has yet been announced, and as these charges form a substantial addition to the total cost of material, it is quite consistent that buyers should expect some concession in this direction. At Sheffield, the volume of overseas inquiries continues favourable to an expansion of business, while in many branches of the steel industry specially catering for the foreign markets, heavy steel trade prospects are brighter; but the crucible branch, and more especially high-speed steel, still remains slack. The rush of high-speed steel deliveries to the States is now about over, and the impression prevails that the new tariff proposals will shortly become law, in much their present form, and there is consequently no time left to get further orders across within a reasonable margin of time. Travellers returning from the States report diverse views on the new tariffs, but the general idea seems to be that while the majority do not want them they will be duly passed by the Senate on much the same lines as the passing of prohibition.

Scrap.

Transactions in all kinds of scrap metal during the past week have been on a restricted scale in the Cleveland market, but in the case of heavy steel the demand is slowly but steadily increasing, with prices fluctuating between 62s. and 63s. per ton, delivered at works. There are distinct indications that a scarcity of suitable material is being felt throughout the district. Turnings and borings are in fairly good demand, but only limited supplies will be available until the engineering works resume active operations. Cast-iron machinery scrap is in poor demand on the North East Coast, and nominal prices remain unchanged at £3 17s. 6d. per ton. Prices for heavy wrought-iron, all classes, remain stationary, the demand being almost non-existent.

Tinplates.

Some improvement may be noted in the general conditions now ruling in the tinplate market, but business on the whole is quiet and uneventful. The lower prices ruling have, however, induced a good many buyers to make purchases, mainly for spot delivery, and although there is not a great deal of forward trade reported the tone all round is distinctly better. The standard size was done at 19s. 6d. for August, 19s. 4½d. for September, 19s. 3d. being taken here and there for delivery beyond this. Current quotations may be called :—Coke tins, I C 14 by 20, 112 sheets, 108 lbs., 19s. 4½d. to 19s. 6d. per box; I C 28 by 20, 112 sheets, 216 lbs., 38s. 10½d. to 39s. 3d. per box, net cash, f.o.b. Wales.

Metals.

Copper.—An easier tendency has mostly ruled in the week's standard copper market, business having been on a restricted scale owing to the holidays, while purchases on home consumption account have been reduced within moderate limits. The Continent, also, is taking only small parcels to meet present requirements, any expansion of buying in that direction being restrained by exchange difficulties. Labour troubles in the States restrict consumption for the time being, but it is anticipated that a settlement of the dispute would be immediately followed by a substantial demand, for which the stocks at present available are likely to be inadequate. Current quotations :

Cash : Wednesday, £64 12s. 6d.; Thursday, £64 2s. 6d.; Friday, £64 2s. 6d.; Monday, £64 2s. 6d.; Tuesday, £63 17s. 6d. *Three Months*: Wednesday, £64 15s.; Thursday, £64 5s.; Friday, £64 5s.; Monday, £64 5s.; Tuesday, £64.

Tin.—The position in the standard tin market during the current week has disclosed few features of outstanding importance. Values have fallen considerably, owing to the withdrawal of influential support from the market and a temporary decrease in consumptive demand. The latter may be explained by the fact that the Welsh tinplate mills are idle from holiday reasons, conditions likely to exist until the inflow of autumn orders materialises. Sales in the Eastern markets are now in more moderate volume and are reported at rather lower figures than have prevailed of late. Current quotations :—

Cash : Wednesday, £160 2s. 6d.; Thursday, £159 2s. 6d.; Friday, £158 10s.; Monday, £158 15s.; Tuesday, £158 17s. 6d. *Three Months*: Wednesday, £160 5s.; Thursday, £159 7s. 6d.; Friday, £158 15s.; Monday, £159.

Spelter.—Values of this metal are firmly maintained, and so far market movements indicate a further steady appreciation, due to limited supplies, and abnormally reduced stocks in the States. Continental producers are reported well booked and are apparently indifferent to offers of forward business. Current quotations :—

Ordinary: Wednesday, £31 10s.; Thursday, £31 5s.; Friday, £31; Monday, £31 5s.; Tuesday, £31 5s.

Lead.—Only a quiet business is passing at the moment in the market for soft foreign pig, with prices showing a declining tendency. Stocks in hand are at a low level, the figures for the end of July standing at 235 tons, as compared with 268 tons at the same period in June. Current quotations :—

Soft foreign (prompt): Wednesday, £25 12s. 6d.; Thursday, £25 7s. 6d.; Friday, £25; Monday, £25 5s.; Tuesday, £25 5s.

Book Review.

INDUSTRIAL UNREST: A WAY OUT, by B. Seebohm Rowntree. Published by Messrs. Longmans, Green & Company, Limited, Paternoster Row, London, E.C.4. Price 1s. net.

The author of this little book has set out to show that industrial unrest can be cured by the application of various schemes having for their end the amelioration of the workers' position. As the book is somewhat of a political nature, it is beyond our province to express any views on its merits or demerits.

MESSRS. AUGUST'S MUFFLE FURNACES, LIMITED, of Thorn Tree Works, King Cross, Halifax, have recently received three repeat orders and five new orders for their standard patent muffle furnaces, for heat-treatment, normalising, annealing, and case-hardening, and a very large order for a battery of eight of their various types of core and mould drying ovens from one of the largest textile machinery manufacturers in the country.

MISCELLANEOUS. (Continued from p. 18.

PENCIL GANISTER, of high quality and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

FOR SALE—LOAM MILL, 4 ft., Pan first class order, £30; 1 and 2-cwt. Ladles; 2 Cupolas for 2 and 4 tons per hour; Foundry Travelling Crane 10ft. span, to lift up to 4 tons, £50; quantity Grinding Wheels from 3 in. up to 40 in. diam.; new.—GEO. DEAN, Engineer, Vulcan Street, Cobridge, Staffs.

THE PROPRIETOR OF BRITISH PATENT No. 127462, dated August 13, 1918, relating to "MATERIAL CONVEYORS FOR FURNACES," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

Appointment of Director of Research.

The Council invite applications for the post of Director of Research of the Association at a commencing Salary not exceeding £900 per annum, according to Scientific attainments, and Foundry, Blast Furnace or other suitable Industrial experience.

Forms of application can be obtained from the undersigned, which are to be returned on or before August 31st, 1922.—THOMAS VICKERS, Secretary, Central House, New Street, Birmingham.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	17	6
Three months	64	5	0
Electrolytic	70	0	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	5	0
Do. Aug.	71	5	0
Do. Sept.	71	5	0
Ingot bars	70	10	0
H.C. wire rods	76	0	0
Off. aver. cash, July	63	3	7 3/14
Do. 3 mths., July	63	10	5 5/14
Do. Settlement July	63	3	2 2/7
Do. Electro, July	71	0	0
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July	71	13	7

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6¼d.
Do. 4x4 Squares .. 8¼d.
Do. 4x3 Sheets .. 9¼d

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes 13d
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6¼d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

Standard cash	158	17	6
Three Months	159	0	0
English	158	15	0
Bars	160	10	0
Chinese	157	10	0
Straits	159	15	0
Australian	159	7	6
Eastern	159	10	0
Banca	158	12	6
Off. aver., cash, July	156	4	4 1/7
Do. 3 mths., July	156	14	5 5/7
Do. Sttlment. July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

Ordinary	31	5	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	35	10	0
English	31	15	0
India	24	0	0
Prime Western	31	7	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., July	28	18	5 1/14
Aver., spot, July	29	0	10¾

LEAD.

Soft foreign ppt	25	5	0
English	26	0	0
Off. average, July	24	6	11¼
Average spot, July	24	17	4½

ZINC SHEETS.

Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	37	10	0
Dutch	37	10	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 7 6 to 11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 17 6
75% 22 0 0

Ferro-vanadium—
35/40% 17/6 to 17/9 lb. va.

Ferro-molybdenum—
70/75% 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23

Ferro-chrome—
Max. 2% car. .. £60
Max. 1% car. .. £70
Max. 0.70% car. .. £78
67/70%, carbonless 1/7½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 10/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb

Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	2	17	6	3	7	6
Mixed iron & steel	2	19	0	3	7	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries		4	0	0		
Cleveland—						
Heavy steel		3	2	6		
Steel turnings		2	5	0		
Cast-iron borings		2	5	0		
Heavy forge		3	12	6		
Bushelled scrap		3	2	6		
Cast-iron scrap		3	17	6		
Lancashire—						
Cast iron scrap		4	0	0		
Heavy wrought		3	10	0		
Steel turnings		2	2	6		
London—	£	s.	d.			
Copper (clean)	57	0	0			
Brass (clean)	31	0	0			
Lead (less usual draft)	21	0	0			
Tea lead	19	0	0			
Zinc	17	0	0			
New aluminium cuttings	60	0	0			
Braziery copper	47	0	0			
Gun metal	41	0	0			
Hollow pewter	125	0	0			
Shaped black pewter	80	0	0			

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—
Foundry No. 1 .. 95/-
Foundry No. 3 .. 87/-
Forge No. 4 .. .. 85/-
Mottled 80/-
Hematite No. 1 .. 90/6
Hematite M/Nos. .. 90/-
Midlands—
Staffs. common .. —
,, part-mine forge —
,, ,, foundry —
,, Cold blast ... 240/-
,, basio .. .. —
Northants forge 70/- to 72/6
,, foundry No. 3 77/6 ,, 80/-
,, basio 82/6
Derbyshire forge .. 75/-
,, foundry No. 3 82/6
,, basic .. 80/-
Scotland—
Foundry No. 1 .. 100/-
,, No. 3 .. 95/-
Hematite M/Nos. .. 107/6
Sheffield (d/d district)—
Derby forge 82/6
,, foundry No. 3 86/6
,, basic .. .. —
Lincs. forge 86/6
,, foundry No. 3 86/6
,, basio 86/6
E.C. hematite .. 101/2
W.C. hematite .. 104/-
All d/d in the district.
Lancashire (d/d eq. Man.) —
Derby forge .. .. —
,, foundry No. 3 92/6
Northants foundry No. 3 .. .. —
Cleveland foundry No. 3 .. .. —
Staffs. foundry No. 3 —
Lincs. forge .. .. —
,, foundry No. 3 —
Summerlee foundry .. 112/-
Glengarnock foundry 114/6
Gartsherrie foundry 114/6
Monkland foundry .. 112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.) £10 10 to 11	10	0	
Angles .. £11 to 11	10	0	
Tees to 3 united ins. £11 10 to 12	0	0	
Nut and bolt ..	9	17	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip ..	11	2	6
Bolts and nuts, ⅝ in. × 4 in.	19	10	0
Steel—			
Ship plates ..	9	0	0
Boiler plates ..	12	10	0
Chequer plates	10	10	0
Angles	8	12	6
Tees	9	12	6
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in. ..	10	10	0
Rounds, under 3in. to ⅝in. ..	9	10	0
Flats, over 5in. wide and up ..	10	0	0
Flats 5in. to 1¼in.	8	10	0

	£	s.	d.
Rails, heavy ..	9	0	0
Fishplates ..	14	10	0
Hoops	11	15	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ¾ in. dia	14	0	0
Billets, soft 7 0 0 to 7	5	0	
Billets, hard ..	8	0	0
Sheet bars 7 5 0 to 7	7	6	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3¾
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11¼
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6¾ to 2/0¾
To 21 in. wide	1/7⅛ to 2/1⅛
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8

Wire round—
3/0 to 10. G. .. 1/8½ to 2/3½ with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.76
No. 2 foundry Valley	28.00
No. 2 foundry, Birm.	18.50
Basio	26.96
Bessemer	26.76
Malleable	28.96
Grey forge	27.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila. ..	2.02
Steel bars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel ..	1.70
Skelp, sheared steel ..	1.70
Steel hoops	2.50
Sheets, black, No. 28 ..	3.15
Sheets, galv., No. 28 ..	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv. ..	3.05
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry 35/-
,, furnace 30/-
Durham & North. foundry 28/-
,, furnace .. 23/6
Other Districts, foundry 27/6
,, furnace 22/6

THE

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Contents.

	PAGE
The Age of Semi-Steel	151
Research Work and the Chemical Analysis of Cast Iron	151
Correspondence	152
Catalogues Received	152
An Apprenticeship Course in Foundry Practice VI.	153
Some Overhead Foundry Runways	157
Metal Breaking with Explosives	158
A Fettling Shop Speciality	159
Use of Carbon Dioxide Recorders in Controlling Combustion of Powdered Coal	159
Melting Steel and Cast Iron together in the Cupola	160
Simplifying Cores for Water-Cooled Journal Box	162
Views on Mr. Smalley's Paper on High Tenacity Brasses	163
Some Notes on Semi-Steel and Loam Moulding	164
Concerning Machine Moulding	164
Prof. Loureda's Paper on Malleable Iron Discussed	165
Discussion on Prof. Campion's and Mr. Donaldson's Paper on Strength of Cast Iron at Low Temperatures	165
Iron and Steel Output in July	166
American Specifications for Semi-Steel Castings	167
The Analysis of Cupola Slag	168
Malleable Castings	169

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Age of Semi-Steel.

In the second edition (1882) of a book entitled "La Fonderie en France," originally published in 1844, reference is made to a patented mixture containing 60 parts of grey pig-iron, 20 parts wrought-iron scrap, 20 parts of wrought-iron turnings, 3 parts manganese, and 2 parts of borax. What the author meant by manganese it is difficult to say. It might have reference to ferro-manganese, spiegeleisen, or even manganese ore. Further reference to semi-steel is made in another patented mixture, wherein it is recommended to use 3 to 15 parts of steel, semi-steel (demi-acier) or malleable iron to 100 kilos. of ordinary grey iron. Full reference is made to Stirling, who is thought by many to be the originator of semi-steel, but, additionally, the Morries-Stirling process is also dealt with. If any of our readers can throw more light on the origin of the incorporation of steel in cupola charges we shall be happy to have their references.

Research Work and the Chemical Analysis of Cast-Iron.

By H. J. Young, F.I.C.

"All possible care must therefore be exercised in the initial stage, and the laboratory results examined and checked in the smallest detail."

"So much depends upon the process of analysis resting on an unassailable basis."

"In experimental investigation great attention must be given to detail. Where this is not fully realised, conclusions may be drawn from premises which are either incomplete or incorrect."

The above passages from Dreaper's "Notes on Chemical Research" have some considerable bearing upon the present position in the metallurgy of cast-iron and of ironfoundry practice.

Cast-iron, one of the most impure or, at any rate, one of the most intricately impure materials of commerce, is full of mysteries and contradictions. A study of the literature of cast-iron and its properties and manufacture will reveal this fact to an amazing degree. What is apparently proved by one worker is apparently disproved by another. Take the effect of sulphur, for instance, and it will be found that whilst one man says it is harmful another says it is beneficial, that whilst one pig-iron is commended for its low sulphur-content, exactly the opposite is the case of certain white irons which are equally commended.

The inquiring foundryman is unfamiliar with the difficulties of chemical analysis, as, indeed, are many analysts, and he does not appear to realise that an analysis has in itself no particular standard of accuracy. It all depends; and therefore thousands of analyses, though perhaps quite sufficiently good for their original purpose, are entirely valueless, and even misleading, as proofs of any theory or, possibly, of any fact.

Foundrymen are, for instance, faced with the problem as to why two pig-irons of apparently similar composition give castings of widely different properties. The most unscientific person would probably ask whether one can be *certain* that the compositions *are* similar, and in so asking would he indicate the vital point of the problem, and one that foundry workers have either overlooked or under-valued.

To determine beyond doubt whether two pig-irons or cast-irons do or do not possess precisely similar compositions requires greater accuracy, experience and knowledge than the ordinary analyst is to be expected to have. In the first place, the analyst will have to prove the accuracy of his method and of his way of working that method, and, in the second place, he will need to compare the results obtained by his method with those obtained by other methods; thirdly, he will need to investigate whether his method is applicable, with equal accuracy, to any iron of any composition; and, lastly, he will need to prove that the final result really represents the element he is estimating, or whether it includes other elements or compounds.

Of course, in everyday laboratory practice, this is not done, and in some laboratories it never has been done. One simply uses some method out of a book handled during earlier training. In many laboratories the methods, though good in themselves, are worked wrongly or in a slovenly fashion, or are applied to unsuitable purposes. It takes many years to train a man to be an accurate analyst, and there is no certainty that he will be one even after those years of training. It depends upon the training and upon the man. Some chemists say that analysts are born rather than made. Certainly it is the writer's experience that

not one out of a hundred ordinary boys has the qualities essential to the making of an accurate analyst, no matter how much training he may have—nothing like one in a hundred.

The object of this article is not to prove that there are analysts of differing calibre—that is already well recognised by chemists themselves—but to show that the value of any research upon cast-iron depends almost entirely upon the correct analysis of the specimens under investigation. Some years back one of our leading engineers caused to be prepared a standard sample of cast-iron, which he sent round to a number of laboratories of all kinds all over the country. The results were deplorably poor, and, in many cases, ludicrous.

Naturally, one can hear the foundryman say to himself, "Well, what does it matter if it does differ a little either way? It is merely splitting hairs to talk in this manner about an analysis." Thereby does the unscientifically trained man make an enormous mistake; the success or failure of most things depends more upon small matters than upon large ones, and that is as much true as regards foundrywork as regards anything.

A little, a very little, strychnine will turn a glass of water into a good tonic; a little more, a very little more, will turn the mixture into a deadly poison. In metals and alloys we know of quite a number of things with strychnine-like effects. Ask the metal-rolling trades what they think about minute impurities and small amounts of other additions (not impurities)—they will tell you that they are the principal things to think about in their trades.

In cast-iron it is not yet known what is and what is not important. It must be something exceedingly small that makes two irons have very different properties, even though their compositions are apparently similar. True, it may be something to do with inherent properties, but, on the other hand, it may be due to composition, and, before accepting the former theory, it will be necessary to prove the latter.

The common analysis of cast-iron *includes* carbons, silicon, phosphorus, sulphur and manganese, and it is an exceedingly difficult analysis to make correctly, particularly in certain irons. The common analysis of cast-iron *does not include* titanium, copper, nickel, arsenic, chromium, tungsten, etc., to say nothing of the various gases and compounds of those gases; and, moreover, it is unfortunately true to say that the estimation of some of these things is, at the present time, very indecisive, and, in some cases, altogether impossible.

It is a brave man, and a rash man, who says that the properties of cast-iron do not depend upon composition, and he has got a great deal of work before him if he desires to prove his statement.

Considering one or two concrete and simple cases. Suppose two cast-irons are analysed for the ordinary elements, and one of them is found to contain 0.10 per cent. more silicon than the other, but is the same as the other in all else. Will anyone say that the 0.10 per cent. silicon does not matter and that the irons are precisely alike? Or suppose, instead of 0.10 per cent. silicon, the difference was 0.05 per cent. manganese, or 0.05 per cent. phosphorus, of 0.05 per cent. carbon, or 0.01 per cent. sulphur. Who can say what does and what does not matter? The writer knows of several foundrymen who say these things do not matter, but they are speaking without metallurgical training and are unaware of the possibilities.

Suppose it takes 0.13 parts of A to combine with 0.017 parts of B to form a compound AB; then it follows that, if there are 0.18 parts of A, there will be an excess of 0.05 parts; or, if there are 0.022 parts of B, there will be an excess of 0.005 parts of B. Then suppose that A or B happens to be like strychnine, does it not follow that the slightest excess over that required to form the compound AB will be beneficial or fatal to the result, and this even though the compound AB may, in itself, be comparatively inactive?

Let us therefore start at the beginning, and discover for a certainty the actual values of the various elements in cast-iron. A large job, no doubt, but if a number of enthusiasts work toward, those ends, it will be not overwhelming to anyone, however limited may be his facilities.

It will be understood that the above remarks are written for foundrymen rather than for trained chemists. The latter take an analysis with as much salt as is suitable for the brand, while the former are unable to judge the required amount, and are liable even to believe that an analysis—any old analysis—is *necessarily* a perfectly accurate measurement.

Correspondence.

Mr. Cook's American Exchange Paper.

To the Editor of The Foundry Trade Journal.

Sir,—Your leader on the above subject in the Journal of August 10 brings up once again the old question as to the most desirable shape and size of test-bar to be used for testing cast iron. Certainly it would be much easier to compare the results of the different workers in our own and various other countries if the bars were all of one standard design, prepared and cast in a specified manner; but it is not impossible to overrate the value of the test-bar. We ought not to forget that test-bars in themselves are not the "be all and end all" of foundry practice. While they are, of course, necessary in order to show up the strength and suitability of the metal, the castings themselves are, or should be, always first in importance, and undue consideration should not be given to the test-bars as such. In other words, test-bars should be considered in relation to the castings and not independently. The progress of the foundry depends primarily on the castings themselves; first we learn to make the castings, and secondly we endeavour to find stronger and more satisfactory mixtures with which to cast them, always bearing in mind that the metal must be such as to meet the needs of the casting. If the matter be considered in this light, it will be seen that, in our present state of knowledge, no one form of physical test will cover all possible requirements. It may even be, as Mr. Young suggests, a stumbling-block to progress to concentrate too much on one particular kind of test-bar, as, in his opinion, has been done in America.—Yours, etc.,

Ernest Wheeler.

Manchester, August 19.

Catalogues Received.

W. H. A. Robertson & Company, Limited. Air compressors.

Robert Spelling & Company, 88, Chancery Lane, London, W.C.2, "The service we render."

Alldays & Onions, Limited, of 40-44 Holborn Viaduct, London, E.C.1, List M.T., being an abridged list of their general catalogue. This firm issue some 22 sections, together with a binding case, provided with a tabulated index. Firms having such a holder are registered, and are sure of receiving new editions as published.

Visit to Keighley Laboratories.—Members of the Burnley section of the Lancashire Branch of the Institution of British Foundrymen are to inspect the Keighley Laboratories on August 26.

Railway Situation in Canada.—Cables from Montreal state that the threatened strike of the railway shopmen has been averted temporarily, owing to the action of the Presidents of the Canadian National Railway, the Grand Trunk Railway, and the Canadian Pacific Railway, in telegraphing to the Premier rescinding the recent wage cuts in conformity with the view that the railways should accept the ruling of the Department of Justice, viz., that the reduction is illegal before the Conciliation Board has acted.

Electricity in New Zealand.—A report to the Marawatu-Orona Electric Power Board in New Zealand outlines a scheme for hydro-electricity distribution involving an expenditure of £434,439. The Board has decided to borrow £500,000 to carry out the undertaking. In connection with the Mangahao hydro-electric scheme in the North Island of New Zealand, tenders have been called by the Public Works Tenders Board for the supply of plant as follows:—Power-house transformers, sub-station transformers, electric travelling cranes, ventilating fans, goods lift and 110,000-volt insulators. Tenders close on October 3.

An Apprenticeship Course in Foundry Practice.—VI.

By Ben Shaw and James Edgar.

NOTES ON PATTERN-MAKERS' TOOLS.

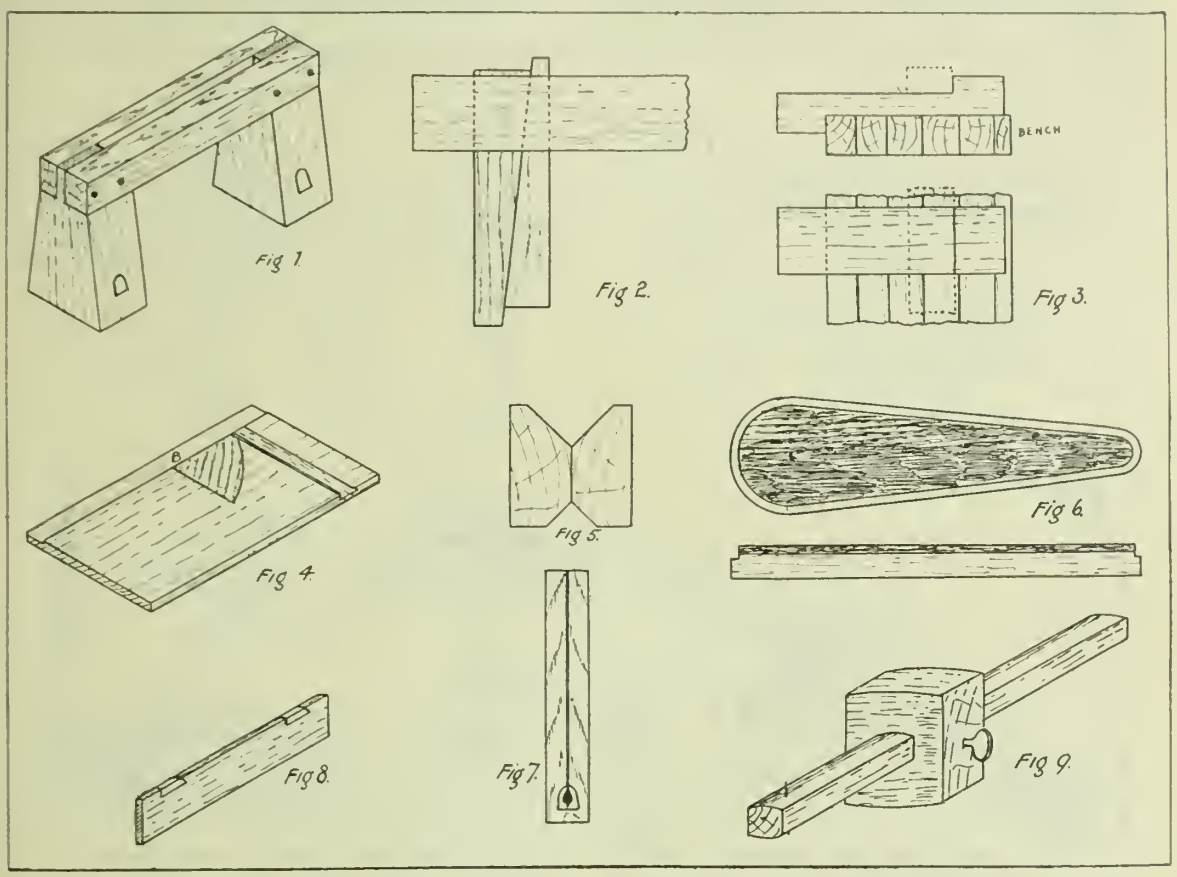
It would be very difficult if not impossible to give instructions on the actual use of pattern-makers' edge tools that would be of value to the novice, therefore we shall not attempt to do so. There are many general considerations, however, dealing with the care of tools and their specific uses which do not require to be demonstrated to be understood, and which might well be considered by older hands as well as apprentices. Pattern-makers' tools may be classified for convenience under three heads, viz., bench equipment, setting out and testing tools and edge tools.

Bench Equipment.

The pattern-makers' bench differs from the cabinet-makers' bench in that the latter is usually provided with two vices and cupboards, whereas the pattern-maker has one vice and one drawer. The best form of bench is that in which the front half of the top is made of 1½-in. or 2-in. yellow pine about 3½ in. or 4 in. wide, bolted together with the annual rings vertical. This makes a very reliable planing surface, and it wears regularly. Sometimes plane tree or sycamore of about 1½ in. thickness is used for bench tops, and if care has been exercised in machining them straight and out of winding they are valuable as surface tables for the smaller class of work made on the bench. Straight-grained wood is necessary to prevent twisting preferably with the annual rings vertical for increased wear. A rack should always be fitted to the back of the bench or in the case of a double-bench a centre back should be made similar to Fig. 1 to hold all edge tools. This is much better than cutting a slot in the bench top, and much safer. A strip of thin wood at the top end of the bench forms a support for the planes and prevents their cutting edges being snipped by resting on the wood. Little need be said about the vice except that the most convenient form is the iron quick-acting vice. Another form of vertical vice is the Emmott vice. Although not quick-acting it is very valuable to the pattern-maker because it can be adjusted to varying angles, an advantage when shaping the work.

Bench Stops.

The bench stop, the object of which is to prevent work from slipping on the bench while it is being planed, is indispensable, and is made in many forms. Adjustable iron bench stops have much to recommend them, although the result is disastrous to the plane iron if the timber which is being planed slips. Some pattern-makers are satisfied with nailing a strip of thin wood to the bench, but one of the most serviceable bench stops is the double-wedge type shown at Fig. 2, which is readily adjustable. A hole 2 in. square has first to be cut through the bench top, the stop then fitted as one piece and sawn in two with a fine dimension saw.



Bench Hooks.

The bench hook is a useful bench tool not generally used. When cutting short lengths with the tenon saw it is very convenient and prevents danger of spoiling the bench top. One shoulder grips the front of the bench while the timber rests against the other. (Fig. 3.) When about 5 in. wide it is also useful as a paring board, to which an apprentice should become accustomed in order to protect the bench top.

Shooting Boards.

The shooting board is not as much used now as formerly, because practically all pattern-shops are equipped with trimmers, but the apprentice ought to understand the use of the shooting board, and every bench should have one. They are useful for many purposes, one of these being the jointing of segments. Fig. 4 shows a typical form of shooting board. The segment or piece of timber to be planed rests on top surface as shown, the stop being a strip of hardwood dovetailed across the width of the board. The plane rests on the recess B.

Fillet Boards.

Akin to the shooting board is the fillet board on which special fillets can be planed. This is usually made about 2 ft. long and of two pieces screwed together (Fig. 5), although the recess can be readily cut from solid timber at the dimension saw by setting the fence at an angle of 45 deg. and raising the saw to the desired height.

Oilstones and Strops.

An essential part of bench equipment are the oilstones and the strops. There is no tool in the pattern-maker's kit that is of greater importance than the oilstone because the condition of all the edge tools depends upon the condition of the oilstone. It is impossible to sharpen edge tools on a gritty stone or one that is not absolutely level. It is quite impossible to get satisfactory results from a cracked stone or one with broken edges. The apprentice should cultivate a habit of levelling his stone at least once a week, and also smoothing his gouge-slip. One or two rubs on a sheet of emery paper suffice to remove irregularities, the emery paper being placed on a bench surface such as a machine table. Many use the sand-papering machine for levelling stones, a method which is never satisfactory to the stone, and in addition it has a ruinous effect on the sand-paper of the machine, and should not be encouraged. With regard to the oil that is used in sharpening, any oil other than linseed is suitable. Linseed oil clogs the pores. Sperm is good; olive oil is also satisfactory, but ordinary sweet oil is as good as either.

Natural or Artificial Stones?

Are natural or artificial stones the better? There is more choice of form and grade with artificial stones, and a very useful feature is that a stone can be obtained with one face coarse and the other fine. A coarse stone is necessary for turning tools and for removing small nips from chisels or plane irons, and nearly all pattern-makers have a special stone for these. There are several kinds of natural and artificial stones, but to rub up a fine edge on carving gouges or thin chisels the Arkansas is unequalled. It is hard and the grain is exceedingly fine, therefore it is slow. A good Turkish stone is a valuable asset to the pattern-maker, but the right grade is so difficult to obtain that those who possess one prize it highly. Washita stones are coarser and cut more rapidly, but they are quite satisfactory. The best known of the artificial stones is Indian oilstone, which is made of Indian corundum.

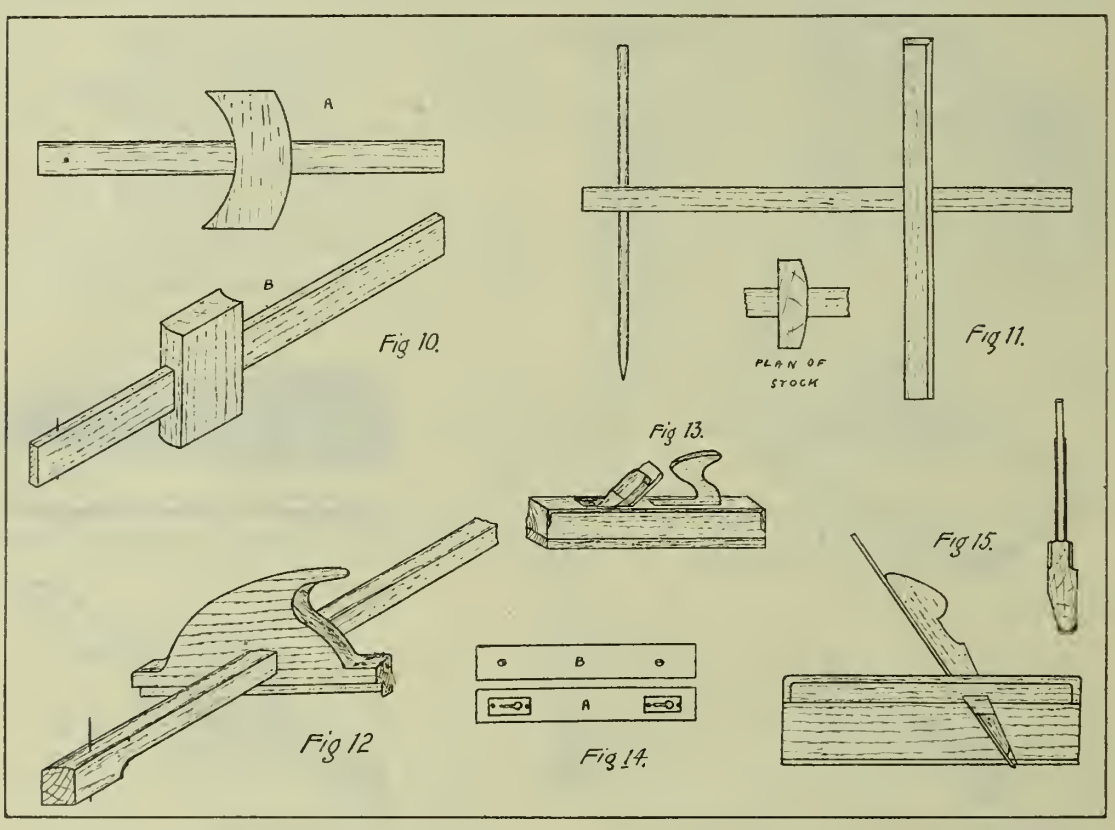
A broad stone is always preferable to a narrow one. A sensitive touch is valuable in determining whether a stone is coarse or fine. Soft places on a stone can be detected readily with a moist sponge because they absorb the moisture more readily. Flat stones should either be held in an iron stand or fitted into a hardwood case with a lid to exclude dust. Cases are sometimes coated inside with white lead and the stone bedded in, a practice which is unnecessary and inadvisable. Gouge slips should also be fitted in cases as they are easily broken.

Strops.

With regard to strops, sometimes a strip of leather is glued on top of the oilstone case and this is admissible if a cover is made for it. It is very important that the strip should be covered. A strop is also necessary for gouges. Different forms of gouge strops are used, but the tapered leather strip mounted on timber and covered is as good as any. An illustration of this is seen in Fig. 6.

SETTING-OUT AND TESTING TOOLS.

A good standard rule is the pattern-maker's most useful measuring tool. A steel contraction rule is also a necessity, and it ought to be marked for steel, iron and brass, although the young pattern-maker may be warned against allowing himself to become the slave of his contraction rule. For comparatively small work it is reliable; for large work it is merely a useful aid.



Try-Squares and Set-Squares.

Try-squares with blades 4 in. long to 3 ft. long are used by the pattern-maker. The American combination square is almost invariably used now, but the pattern-maker should make his own large wooden square of oak or mahogany. Set-squares are also invaluable, and are generally made of hardwood. The construction of a large try-square is not really difficult. The width of the blade and stock should depend on the size of the square; 2½ in. is a satisfactory width with a blade ¼ in. thick set into a stock about ¾ in. thick. Care is necessary in jointing the blade and the stock in order that there may be little difficulty in trueing it up afterwards. The correct joint to make is shown by Fig. 16, and after the blade has been glued and pressed into position it is advantageous to insert dowels as shown. Before the blade is

glued, however, it ought to be tested on a flat board, and a good practice is to glue with buttons—small blocks fastened on both sides of stock and blade.

Fig. 17 is an illustration of a form of set square which is very handy for use on large work. The usual shape of a pattern-maker's set-square (Fig. 18) is not satisfactory or reliable for sizes over 18 in. With both try-squares and set-squares occasional truing up is necessary. Attention may be drawn to the protractor on the set-square on Fig. 18, which is useful for setting a bevel to a required angle.

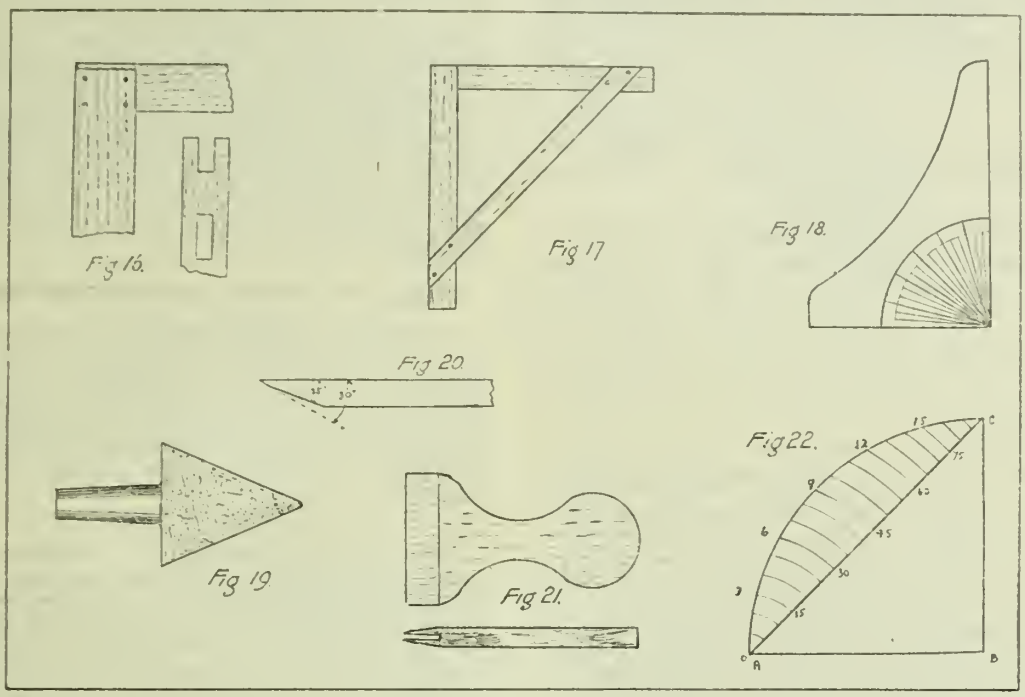
Spirit-Levels and Plumb-Bobs.

In large marine pattern-shops where the work is usually built on level floors, spirit-levels and plumb-bobs are used. They are also used when setting work in the foundry pit. Combined levels and plumbs are made now, but many pattern-makers still prefer the old-fashioned form of plumb shown at Fig. 7. This may consist of a stick 5 or 6 ft. long and about 5 in. wide carefully planed and with a gauged centre line.

Pattern-makers make their own straight-edges usually of mahogany and of different lengths. No other method is quite as good as winding straight-edges for testing large planed surfaces. If two straight-edges exactly parallel are placed at either end of a planed surface and "sighted" the slightest inaccuracy can be detected. If two strips of wood of a different colour from the straight-edges are inset into one of them and this is placed on the work at the end farthest away they constitute a distinct improvement (Fig. 8). Boxwood strips are usually fitted into mahogany straight-edges, although sycamore or other light-coloured hardwood can also be used.

Gauges.

The surface gauge is not greatly used by pattern-makers, but it is very handy. The ordinary marking gauge is the most useful gauge, but a long-toothed or spider gauge for depth is almost a necessity, and other valuable gauges are those known as panel gauges and circle gauges. Designs for gauges are not altogether stereotyped, and many men originate new forms of gauges to suit certain work. The customary form of marking gauge is as shown at Fig. 9, with stock about 7 or 8 in. long, and there are many wedge and screw methods of fixing the head, and the choice is determined by unexplainable personal liking rather than the superiority of one method. It is a simple tool, but some practice is required for good results. The head is gripped between the thumb and first two fingers and held firmly while being pressed against the edge of the wood. Two



arms of circle gauges are in common use, one of these is very similar to the bench gauge (A, Fig. 10), but it does not accommodate itself very well to a variety of curves, and the thin head gauge (B, Fig. 10) is a better tool. The long-toothed or spider gauge is nearly indispensable. This may be made to also act as a surface gauge. The simplest form is shown by Fig. 11, the head being about 7 in. long by 1½ in. or 1¼ in. wide, the shaft about ⅝ in. square and the pin say 3-16 in. in diameter. Some craftsmen make very fine spider gauges in metal, but the form shown serves very well, and is easily made by the apprentice. The panel gauge, because of the length of the shaft, which may be 2 ft. long, is made somewhat different from the shorter gauges. The shaft is raised from the wood by means of the recess in the head, and the shape of the end of the shaft thus freer action is obtained. This will be clearly seen in Fig. 12.

Trammels, compasses, dividers and scribers are used by the patternmaker for setting out work and inside and outside callipers for testing work. Double-ended callipers are convenient for testing thicknesses, especially if a pattern is being made from an old casting, but other forms of thicknessing callipers are equally as good. Trammels with adjustable points are very useful for building segmental work. Tools which are used for an infinite number of purposes are hermaphrodites, commonly called "jennys," and by some odd-leg callipers.

Cutting or Edge Tools.

Whole volumes have been written on the theory of cutting tools, and the subject is a most engrossing one, although it can only be dealt with superficially here. The pattern-maker chiefly uses three planes, the trying plane, or half-long, as it is called in Scotland, the jack plane and smoothing or "hand" plane. Those planes are called bench planes, as they are so often in use that they are seldom removed from the bench. Wooden planes have gradually given place to iron planes with screw adjustment. The jack plane is the roughing plane; the trying plane is used for finishing straight surfaces, and the smoothing plane is for finishing surfaces that do not require to be accurately level. The rabbet plane, either of wood or iron, is much used for recessing, and is always more satisfactory for this purpose than the router. The router should only be used when, because of the width or depth, it is impossible to use a rabbet plane. A plane, which is described next, capable of taking soles for both hollows and rounds is serviceable. Such round sole-planes are invariably made by the pattern-maker himself, and it is quite common and satisfactory to convert a jack plane for this purpose, at least for large work, a smaller

and narrower plane being more suitable for small radius curves.

Sole-Planes.

For special brass or iron round sole-planes much can be said, but when a jack is used with loose soles it reduces the number of tools, which is important. Even a young apprentice can quite easily alter a jack-plane for this purpose. A thickness of $\frac{5}{8}$ in. should first be gauged from the bottom face of the plant and removed at the circular saw, afterwards planing the face square with the sides. Soles should be planed a parallel thickness, and slot plates—usually made of sheet brass—fitted into the stocks while screws are inserted into the soles with their heads projecting to slip into the slots. Fig. 13 is a view of the plane with a sole attached, while in Fig. 14, A represents the bottom face of the plane showing the slot plates, while B represents a loose face with screws. A loose sole may be made to restore the jack-plane to normal use. Considerable care has to be taken in cutting through the mouth of the plane. Some text-books on pattern-making state that several rabbet planes are necessary, but while a very narrow one is at times useful, the average pattern-maker gets along comfortably with a $1\frac{1}{4}$-in. plane. One important advantage of the wooden plane is the skewed iron when planing across the grain. Small fillet planes are still necessary tools. These may be bought, but they are quite easily made; they have to be made in different widths according to the radius of the sole, and about 7 in. long. One of these useful planes is shown at Fig. 15. As in the case of rabbet-planes, the irons have no cover plate, and a different form of wedge must be used, because of their narrow width.

Another form of round sole-plane is the circular plane or "sow back." It used to be quite common for pattern-makers to have a set of these planes, all of them small for various radii, and one larger plane with a few soles; but the adjustable iron plane in which the sole is made of a flexible strip of steel, which by an ingenious device can be adjusted to almost any radius, is very generally used now, and gives better results than the old-fashioned types.

There are not usually cover irons on round sole-planes; consequently great care has to be taken when the grain is awkward. The cover iron is almost a necessity for the ordinary bench planes, and especially for the trying and smoothing planes. When a plane is pushed forward the projecting edge of the cutting iron cuts a shaving which bends upwards and escapes through the top. The best results are obtained with a plane which has a narrow mouth, as when the weight of the plane and the craftsman are pressed on the timber, splitting cannot occur ahead of the cutting edge. The cover or back iron is also an important factor, because when its edge is close to the cutting iron it breaks the shaving quickly and prevents the grain from tearing. Thus when planing troublesome surfaces the cover edge should be less than 1-32 in. back from the cutting edge.

Grinding and Sharpening Tools.

A few words on grinding and sharpening tools may not be out of place, although a little experience is worth volumes of advice. Some foremen attach so much importance to the grinding of tools that they watch new hands at the grindstone and form an opinion of their worth from the degree of skill which they show. Tools cannot be sharpened properly on a badly-conditioned oilstone, neither can they be ground satisfactorily on a grindstone the surface of which is all lumps and hollows. Slow grinding is better than quick grinding. The edge should be held square across the stone, and only gentle pressure applied with the left hand, the tool handle being gripped with the right. It is more difficult to grind plane-irons than chisels, because of their greater width. The experienced workman can tell by sound if the bevel is resting properly on the stone. When the tool is removed for inspection, to return it to its former position it is convenient to bring that part of the bevel nearest the operator in contact with the stone first and then raise the right hand until the whole of the bevel is in contact. To get a keen edge the bevel should be fairly long. A good supply of water is essential to prevent the tool from heating, and before finally removing it it should be allowed to rest very lightly on the stone. If plane irons are ground round they cannot be satisfactorily sharpened on the oilstone.

In sharpening edge-tools on the oilstone the rubbing action should be regular and steady and the fine wire edge may be removed by placing the back of the tool flat on the stone, and rubbing very gently. The angle at which the tool is sharpened should be slightly more obtuse than the grind as shown at Fig. 20. Plane irons should be rounded slightly at the corners to prevent them from scratching the face of the timber. Inside gouges are frequently ground on the grindstone edges when special emery stones are not part of the shop equipment, but emery cones are more satisfactory (Fig. 19). These emery cones may be easily made. A piece of hardwood is turned conical with a tapered shank which can be pressed tightly into the lathe spindle. The surface of the cone is coated with glue and dipped in emery. After two or three applications of emery and the glue has quite dried the cone is ready for use.

We shall not attempt to enumerate all the tools used in pattern-making, but some tools are used only for specific classes of work. The draw knife is not in general use nor the axe, but they are useful in shops where ships' stern frames, stems and propeller brackets are made, for roughing down built work which cannot be conveniently taken to the band or circular saws.

The young pattern-maker often makes a mistake of striking paring-chisels and gouges with the hammer. It is a safe rule that iron should never be used for striking wood or wood for striking iron. A good hard wood mallet is an important tool, and should always be used for striking tool handles.

THE USE OF MARKING AND CUTTING TOOLS.

In marking off timber the most accurate results are obtained by transferring measurements from the rule to the surface by means of trammels, compasses, or dividers. Both cutting edge and point of scriber should be sharp, the cutting edge only being used for marking across the grain, and the point for marking lines parallel with the grain.

Marking-off Tools.

Before timber is marked off it is necessary in nearly all cases that one face and one edge should be planed straight and square. It is not possible to get the twist out of timber by planing diagonally across the grain. The neophite will always find that a better result and quicker is obtained by holding the plane parallel with the grain. An exception may be made when making irregular surfaces level, particularly when much timber must be removed in the process; then the plane may be used at an angle with the grain for roughing purposes. The most twisted-grained timber is workable if the plane iron is sharp. It is somewhat different with a chisel, however, and it is often necessary to pare across the grain, the bevel side being on top. Pattern-makers should endeavour to acquire such skill in paring vertically that a square for testing is almost unnecessary. The chisel should practically finish the work, sandpaper being used merely to smooth, and when used it should always be wrapped round a rubber with a linoleum or cork face to obviate hollows or rounds. The same remark applies to gouge paring.

Gouges.

No arbitrary list of gouges and chisels can be made out, because pattern-makers differ so much in the use of tools, and edge-tools in particular. The kit cannot contain too many gouges, as the best work is done with a gouge just slightly quicker—of smaller radius—than the work being pared. The highest skill cannot substitute proper tools, and it is impossible to make a satisfactory finish of a large radius with, say, a 1-in. gouge. Crank gouges have become very popular, and every pattern-maker should have a few for corebox or other work where hand clearance is advisable or necessary, but it is not wise to use crank gouges

for vertical paring, as one has not the same control of these tools when used vertically.

Chisels.

With regard to chisels, some men prefer 1¼-in. chisel for general work, while others like 1½ in. It is just as one begins. There should be at least half a dozen chisels in the kit from ¼ in. upwards. For very fine work 1-16 in. chisel is very useful. A good selection of spoon and bent carving gouges is required in pattern-shops where work is fine and intricate. It is seldom that pattern-makers have sufficient carving gouges to render them independent of their shop-mates.

Hand saws are less used in pattern-shops now than was the case at one time, because nearly all shops have circular saws and bandsaws. Even small foundry pattern-shops have generally a machine saw of some kind. The chief use of the cross-cut saw is in breaking out timber. Comparatively few pattern-makers have a ripping saw. The tenon saw cannot be dispensed with, and is one of the tools most frequently used. When in good condition and in the hands of a skilled man the result is so satisfactory that it is almost unnecessary to plane or pare a face that has been sawn. The dovetail saw is very useful for fine work, and the keyhole or pad saw is still occasionally used.

Hammers.

The claw hammer is not much used by pattern-makers, a pin or pene hammer being the usual type. Other important tools are screwdrivers, a brace and bits, bevels, clamps and bradawls. The spokeshave is not as indispensable now as at one time, because sand-papering machines are installed in most pattern-shops, but there are still plenty of uses for it. The iron spokeshave with screw adjustment is superior to the wooden type. It is necessary to make a holder (Fig. 21) for the blade while sharpening.

Scale of Chords.

No pattern-maker's kit is complete which does not contain several scales. One of the most important of these is the scale of chords; others,, such as the odontograph and a scale of wheel proportions, will be explained in a later article. A scale of chords is a distinct acquisition which takes up very little room, and although not in every-day use the apprentice should make one, as it is of great assistance for some classes of work. With its aid angles can be determined accurately on a drawing card. The method of making such a scale is illustrated by Fig. 22. Describe the quadrant A.B.C. and bisect it at point 9. Then divide each part into three equal parts by trial. This will give points 3, 6, 12 and 15. Divide these parts also in three, when each part will measure an angle of 10 degrees. The chord A.C. must now be drawn, and the points transferred to it and numbered 5, 10, 15, etc. The points on the chord must now be transferred to a prepared piece of hardwood resembling a rule and longer than the chord. To illustrate the use of this scale let us suppose that an angle of 75 degrees is required. The distance 0 to 60 (in all cases) is taken as radius and an arc drawn, and then the distance 0 to 75 is lifted and marked on the arc.

The protractor, such as is frequently drawn on the set square, is also used for measuring and marking angles. Precision protractors are obtainable for use on the blades of iron squares.

Work is about to be resumed on the laying of a double-line track from Clydach to Cwmgorse in the Swansea Valley, for the Great Western Railway. Messrs. Walter Scott & Middleton, the Westminster engineers, who began the work before the war, ceased operations in 1914, and have now secured the contract for the completion.

Preliminary work on the site of the new capital power station at Lydney is about to be commenced. The station will eventually have an output of over 20,000 kw., and will cost, with the transmission lines, etc., about £500,000. Power at 33,000 volts will be supplied to collieries and other industrial undertakings in the Forest of Dean and the Stroud Valley. The West Gloucester Electricity Supply Company is to be formed to carry on the undertaking.

Small Overhead Foundry Runways.

A recent issue of "Engineering and Industrial Management" describes a neat and ingenious device which has recently been introduced in Germany; it runs on I-beams, and is fitted with a small electrical winding gear. It is particularly suitable for placing flasks in position, lifting the top off, rapping the pattern and placing the core. This device presents a number of distinctive features. The method employed is unique, and it is the only lifting device of its kind which dispenses with a lifting drum.

The method is as follows: The lifting chain is of somewhat peculiar construction; it consists of alternate links of two kinds, one being a double joint and the other a machined worm or screw section. The whole has the appearance of a very flexible snake. The lifting and lowering is performed by a small pitched-toothed wheel in a horizontal position in the carriage through which the chain passes. The boss of this wheel is extra long—in fact, so long that two of the worm links are always in pitch with the machine-cut thread inside the boss of the wheel. It will thus be seen that if the wheel revolves in a clockwise direction the chain is pulled up, and reversely it is lowered. The method by which the links are joined together permits movement only in two planes, so that the chain cannot revolve round its axis, since also

Fig. 1.—A Small Overhead Foundry Runway.

that portion which is out of use is passed over a small sprocket in the housing of the gear by which it is guided into a receptacle in order to be out of the way of foundry sand and other dirt. One of the obvious advantages of this chain device is the avoidance of speed reduction gear between motor and lifting device, which is generally of the worm and worm-wheel pattern. The electro-motor is in a vertical position, and carries on its spindle merely a small pinion which gears into the above-mentioned wheel. This apparently complex arrangement is, in reality, extremely simple, and will be better understood by reference to the accompanying diagram. The motor is reversible for lifting and lowering, and it is also automatically reversed by the lifting chain itself when it reaches its end position. There are six speeds, both for lifting and lowering, and any change in speed can be effected by a stationary handle which hangs down. There are two such handles—one for lifting and lowering, and the other for speed regulation. The slowest speed is extremely slow, so that the cope can be lifted off so gently that the mould is in no wise injured. As soon as the flask so lifted is clear of the pattern the speed is increased at the discretion of the operator. Similar tackle is likewise fitted with a second motor if required for travelling. This runway is patented in this country.

Mr. P. Midgley has severed his connection with Messrs. Gaston, Limited, of Larden Road, Acton Vale, London, W.3, and is now London manager for Messrs Haighs (Oldham), Limited, 117-119, City Road, E.C.1, machine tool and woodworking machine manufacturers.

Metal Breaking with Explosives.

For all metal breaking operations, including ship-breaking, both above and below water, dynamite is specially recommended for general use owing to its high velocity and its certainty of propagation.

The following information, supplied by Messrs. Nobel Industries, Limited, of Nobel House, Buckingham Gate, London, S.W.1, especially as regards the quantity of explosive necessary, is drawn up merely to serve as a rough guide and to indicate the usual operations entailed in the use of explosive for metal breaking. It will be understood that in work of this nature no rigid rules can be laid down, and the operations in each individual instance can only be judged in the light of previous experience and carried out after preliminary trials.

Cast Metal by Plaster Shot.

The action in breaking cast metal is purely one of fracture by shock as distinct from a cutting action. For this reason the cartridges forming the charge are placed together in the centre of the metal plate, and the charge is not made to extend the full length of the metal to be broken, but is preferably concentrated at the strongest part of it. The metal may be scratched with a chisel in the direction in which it is desired to fracture, and should be thoroughly washed and freed from grease before the charge is applied. The charge should be completely covered with clay pressed firmly down. Cast metal fly wheels can be broken up easily by this method.

Steel Plates by Plaster Shot.—The action in breaking steel plates is essentially one of cutting, not of fracturing as in the case of cast metal, and consequently more explosive is required to carry out the work. The explosive charge must be placed in close contact with the metal along the whole length of the part to be cut, the cartridges packed closely end to end so as to ensure continuity of the charge, and the clay pressed firmly over. The best results are obtained if the surface of the metal is previously roughened by chisel and grease removed.

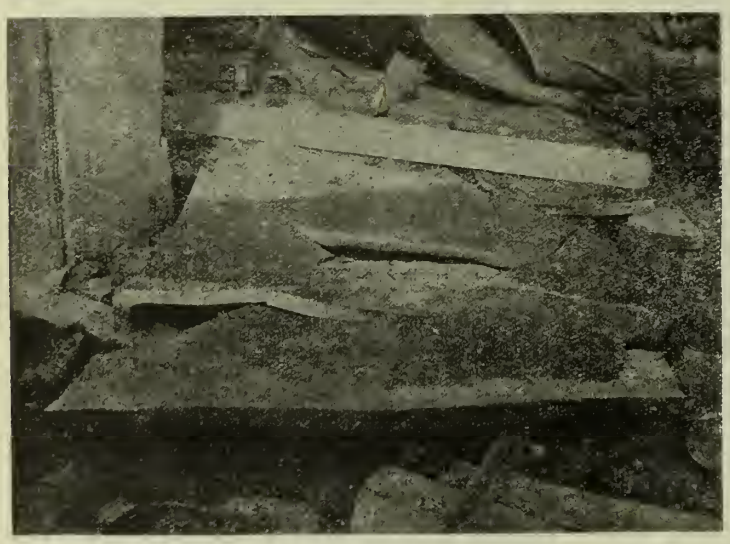


Fig. 2.—Cast-Iron Plate after Blasting by Plaster Shot.

Malleable Iron.—Owing to the tough nature of the material, 25 per cent. more explosive is required than would be used under the same circumstances with steel.

Heavy Metal Castings.

Heavy metal castings in the form of blocks cannot as a rule be broken by plaster shots.

A hole, usually about one inch diameter, is drilled into the centre or strongest part of the block and slightly past the centre, so that the final bursting charge will be as near as possible to the centre of the block. Chambering the bottom of the borehole is generally necessary in order to concentrate the final charge in the centre. The chambering is carried out by firing preliminary charges in the borehole, and the amount of chambering necessary depends, of course, on the size of the final bursting charge required, namely, on the size of the block. In the chambering shots no stemming is required further than firmly plugging the top of the hole with paper or any other convenient material. For the final shot the explosive used should not more than fill the chamber, and the borehole should be filled to the top with stemming firmly tamped. If the explosive charge is not properly centred and fills a part of the borehole so that there is too little stemming, the top part of the metal has a tendency to fly, and the bursting effect of the shot will be lost to some extent.

Fig. 1.—Cast-Iron Plate, 5 ft. Square, 2 in. Thick, before Blasting.

Heavy Metal Vessels.

A hollow casting in the form of a containing vessel, such as a retort or still, can be reduced very easily and cheaply to scrap, of dimensions suitable for handling, by the explosion of a suitable charge suspended in the middle of the vessel, after the latter has been filled with water.

The vessel is filled to the brim with water, and the charge, made up in a waterproof bag and containing an electric detonator, is suspended in the centre of the vessel and fired electrically. If the proper weight of charge is used, the vessel will simply collapse, and the fragmented metal will not be thrown to any extent. A vessel six to seven feet in diameter and six feet deep, the metal of which is two to three inches thick, can be demolished in this way by a single charge of one and a-half pounds of gelignite 50 per cent. N.G., which is the most suitable explosive for this operation.

Boilers and similar heavy metal containers can also be dealt with in this manner.

The breaking of pig-iron into small lengths suitable for the cupola is another useful field for the explosion method.

This method is recommended for use wherever it can be made applicable in view of its simplicity, economy, and the rapidity with which the work can be accomplished.

Breaking Concrete Foundations.—The demolition of concrete and reinforced concrete work,

which is a slow and tedious process by ordinary methods, may be greatly facilitated by explosives. By the proper placing and loading of the holes the solid mass can be broken into material of a size which will permit of easy handling.

Precautions.

In metal breaking operations there is always a danger of debris flying, especially where shots have been overcharged or improperly placed.

To prevent flying debris as far as possible the metal to be broken should always rest as solidly as can be arranged, and for plaster shots the explosive should be placed above the metal to be broken so that the force of the blast is directed downwards.

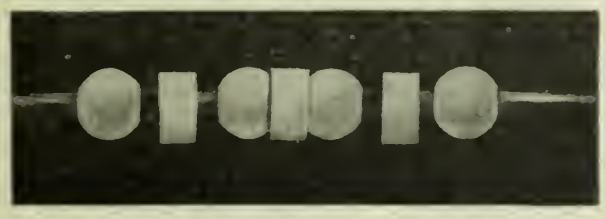
In restricted areas or public places, blasting mats made of hemp rope or steel wire or chain, may be used to cover the shots and catch any flying fragments. In the absence of specially prepared mats, old hemp or jute bags and such like material heaped over the shot are commonly used, and make an efficient substitute, while brushwood, heavy planks, etc., are also used for the same purpose.

Invariably the operator and other observers should be under cover at a safe distance when the shot is fired.

Where metal breaking work is more or less continuous, or a matter of constant routine, it is strongly recommended that a special pit, lined with sheet metal and with heavy metal roofing, be utilised for shot firing operations. Pits of this construction have proved very successful for the purpose at various iron and steel works throughout the country.

"Ballsok" Bead Insulation.

There are numerous wiring details in connection with electrical apparatus where bead insulation of otherwise bare conductors can be employed to advantage. This applies more particularly to internal connections of auto-transformers, switchgear and starting resistances. For this work it has been customary to cover such conductors with glass beads, but a difficulty arose at elbows and bends owing to the gap between each bead exposing the bare wire. The glass bead is also unsatisfactory in that it is incapable of withstanding the high temperatures immediately adjacent to a resistance element itself. The problem presented has been one of completely insulating the wire throughout its length with beads which



"BALLSOK" BEAD INSULATION.

would resist a high temperature and would entirely cover the conductor, whether straight, slightly curved, or bent at a sharp angle. The accompanying illustration shows an ingenious device for this purpose, described as "Ballsok" beads, which have been introduced by Mr. Lionel Robinson, 3, Staple Inn, Holborn, London, W.C.1, who is the sole representative of the makers in this country.

It will be seen that the well-known principle of the ball-and-socket has been applied to the solution of the problem of bare-wire insulation. Each ball bead accurately fits each socket bead on both sides, thereby assuring unbroken contact between each member, and the complete shielding of the bare wire. One of the features of these beads is that both ball and socket, being reversible, can be threaded without chance of error so long as alternate elements are placed on the conductor to be insulated. Should a surplus ball or socket be threaded on by mistake, either can be cracked off with a hammer. The "Ballsok" beads are fire-resisting, and they are non-hygroscopic. It is also interesting to note that they are accurately moulded to 1-1000th in.

A Fettling Shop Speciality.

It is common knowledge that the fettling shop is the most neglected shop in the most neglected department in an engineering works, and we are always pleased to note developments in this direction. Quite often the cleaning shop has to use plant designed for other departments, especially in regard to grinding machinery. The machine illustrated below, however, has been designed specially for dressing castings. The manufacturers

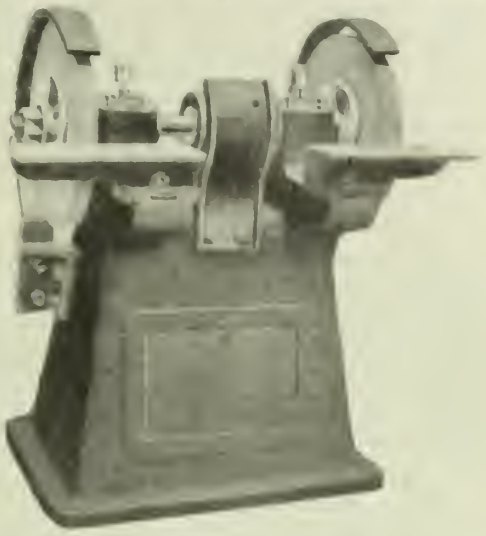


FIG. 1.—A DOUBLE GRINDING MACHINE, SPECIALLY DESIGNED FOR FETTLING SHOPS.

are Messrs. John Warner & Sons, Phœnix Foundry, Hanley. This firm being themselves foundrymen have first-hand knowledge of the duties required. The principal features of this 18-in. double-wheel dry grinder are its sturdy construction and ability to run for long periods without shut-downs for repairs. It takes wheels of 18 in. by 2 in. and 18 in. by 1½ in., but 3-in. wide wheels can be fitted if so desired. It runs at 1,060 revs. per minute, takes up an area of 5 ft. by 4 ft. 6 in., and weighs 8 cwts.

A point worthy of notice is that the size of table allows practically all the weight to be borne by the machine, even though the casting may weigh a hundredweight—a factor not always provided for.

Use of Carbon Dioxide Recorders in Controlling Combustion of Powdered Coal.*

BY D. M. SCOTT, Works Manager, T. H. Symington Co., Rochester, N.Y.

This paper describes the use of carbon dioxide recorders in controlling melting and annealing operations in a malleable cast-iron foundry when powdered coal is used as a fuel. The change from hand firing of air furnaces to powdered coal resulted in a decrease of from 20 per cent. to 50 per cent in the cost of repairs, fuel and labour. While these reductions are most satisfactory, the possibilities of greater economies are apparent from the results obtained with occasional heats run under ideal conditions. The value in determining the carbon dioxide content lies in the fact that it indicates the proportion of air to coal, completeness of combustion and presence of furnace leaks. For furnace or fuel there is a certain mixture of air and fuel that give the best obtainable results. The only accurate guide as to when this correct mixture of air and fuel is being used is by the constant analysis of the fuel gases.

The paper goes into detail regarding investigations undertaken to establish proper furnace and oven practice when using powdered coal. Annealing oven conditions investigated included four distinct types of feeders: horizontal screw, gravity, syphon and vertical screw.

* Abstract of a Paper read before the American Foundrymen's Association.

Melting Steel and Cast Iron together in the Cupola.*

By J. Hogg.

Much experimenting with steel and iron mixings has been carried out by experienced foundrymen, both at home and abroad, and many of them have been extremely successful, chiefly with amounts of steel varying from 10 to 40 per cent.

It has been the practice to refer to cupola melted mixtures of steel and iron as semi-steel. Many ironfounders and engineers have unbounded faith in, and enthusiasm for semi-steel mixtures, for without doubt, such mixtures are extremely useful for certain classes of work. The writer has cast piston rings in large quantities, which have given satisfaction, using a 20 per cent. addition of steel, and has preference for the mixture because of its fine wearing surface.

The writer's first experience in putting steel in the cupola with iron took place about eight or nine years ago. He had to deal with an order for six rollers, about 2 ft. 6 in. dia. with a 12 in. face, and with the order came a request that the castings should be made of a good wearing metal, as those previously supplied were of soft grey-iron and had worn away very rapidly. At the same time the castings had not to be too hard to machine, and had to be dense in character. One of the old hands in the shop advised the putting of a few old files in the ladle and tapping the iron on to them. This method did not appeal to the writer, as he had seen it done in his apprentice days with very indifferent results, and had often heard the method criticised. It was decided to adopt the method recommended by various lecturers at that time and put the steel in the cupola with the iron. Twenty per cent. was charged in small punchings of mild steel, and good rises were made on the castings. The moulds were skin dried, and the results were satisfactory, although the castings were harder than the usual grey-iron mixture, but they machined up very well.

These mixtures have been used very often since that time and have been quite satisfactory.

Steel Turnings Used.

During the latter part of the war, when C.I. shells were being made in large quantities, and a high tensile-test had to be furnished, many foundrymen used steel and iron mixtures, among them was included the writer. Fairly high combined carbon helped to provide a satisfactory tensile test, and the use of steel provided the necessary combined C. without resorting to white iron, which would not be satisfactory for machining purposes. It also helped to provide a good sound casting. On a charge of 10 cwts., 5 cwts. of good scrap was used, 3½ cwts. of pig iron of two brands which were considered suitable, and 1½ cwts. of steel. Owing to the great amount of steel required each day, punchings could not be obtained, so steel shavings from the shell turning department were substituted, the method proved successful. The shells were clean, dense and machineable, the tensile test which was taken from the body of a shell, chosen by the inspector, varied from 12.1 to 14 tons. After a few days' continuous progress, a difficulty arose. The castings began to harden up, and this was soon traced to the re-melt among the scrap, which was used at the proportion of 20 per cent. Reference is made, of course, to runner hoads, risers, and gates. It was necessary to reduce the steel to 1 cwt. per charge for a few days, and this method helped us to soften the castings a little, without affecting greatly the density or the tensile result. The hardness and tensile strength were tested daily, in the morning, and the proportion of steel varied accordingly.

One test gave the following result :—The analysis of one test, which gave tensile 13 tons and machined easily, was Gr.C., 2.70; C.C., 0.65; Si., 1.8; S., 0.11; Mn., 0.34; and P., 0.59 per cent.

It was thought that the Mn. ought to be higher, perhaps double the quantity, and eventually a brand of pig iron was chosen that was thought would give a reasonable amount, but after ordering it the firm was unable to obtain delivery at that period, so no change could be made.

The writer often uses steel now in amounts of 15 per cent., and it is fairly satisfactory, and always so if the metal is poured hot. Small pieces of plate or cuttings of mild steel bars seem to be best for the purpose.

Practical Details.

A good bed of coke is used of good quality. The pig-iron is placed on the coke and limestone, then the steel, and last of all the scrap. No receiver is attached, but effort is made to get the charge melted completely before tapping into the ladle, because it is presumed that the charge must be well mixed.

A very high temperature is favoured, as the metal had to be very hot when poured, because of the danger of hard spots. If the mould is a green sand one it is best to have it on the dry side if possible. A dry sand mould would be better still for the purpose. If the metal is at all "dull," blow-holes are almost certain to appear when machining the castings, or if the metal is not well mixed, or the mould damp, hard places will appear, causing the casting to be rejected. It is advisable to have the metal analysed at intervals, or at least to test for combined carbon, which must not get above 0.85 per cent., if the castings require machining.

A Simple Hardness Test.

A test the writer has had strongly recommended to him for testing the percentage of combined carbon is to polish a small sample of the iron and then boil it for a few moments in sodium picrate. The combined carbon will assume a rich brown colour, and there is not much difficulty in judging its amount from day to day. This is a special test for hardness, and can be carried out by means of a low power microscope.

Applicability of Semi-steel.

Steel additions are also useful for getting a good transverse strength, and it is particularly applicable for beams, girders, pipes which may have to hang over a large span, without much support and even light section castings which do not require much machining, such as levers for valve work. Ten per cent. of steel added to 40 per cent. pig and 50 per cent. good scrap will give good results if mixed properly and melted at a fairly high temperature. Common iron with steel added are often made to fill the place of higher-priced irons. Personally the writer would not eliminate the better class iron entirely, but reduce the quantity, say, from 20 to 10 per cent., or in such proportion as may be considered necessary. Of course, these mixtures will not take the place of steel itself. It has been found that firms which were having castings made in steel, and after hearing of the so-called semi-steel, decided to change over to this product because of the price. They have made the mistake of expecting semi-steel to replace steel, but needless to say it will not do that. For improving grey cast iron it is eminently suitable when used with discretion.

Order of Charging.

In a jobbing foundry where different mixings of metal are required, and some of them are to be steel mixtures, it is suggested that about two tons of grey cast-iron be melted first, so that the cupola may have a change of becoming heated to a high temperature before starting to charge the iron and steel mixtures. An extra layer of coke may be placed above the last grey-iron charge, so that the grey-iron charge may have time to be removed before the steel mixtures begins to melt and fall into the bottom of the cupola. The lighter cast scrap will, of course, be put on the last of each charge.

The coke should not be used too sparingly with an iron and steel mixture. Of course, it is not meant that it should be wasted, but sufficient

* A paper read before the Lancashire Branch (Burnley Section) the Institution of British Foundrymen.

should be used to ensure hot melting. If possible the metal should come down the spout bright white in appearance, or even dazzling white, if it has any distance to be carried. The writer would say that he has found Poulett's table, published in Professor Rhead's book on iron founding, a useful method of judging the temperature of molten metal without a pyrometer.

An excess of limestone should be guarded against, as owing to the high temperature used in the cupola it may result in destroying the cupola lining and the face of the bricks.

The lecturer hopes the remarks made are as plain and as practical as he had hoped they would be. Perhaps more details about the structure of the mixtures might have been given and also of the method of melting the steel, and of the steel taking up its carbon from the coke, etc., before becoming fusible, but he felt that first of all interest must be aroused, and then one would be able to take up the study of the subject more deeply afterwards.

He is not prepared to recommend the addition of steel to the metal in the ladles, because of one vital point. It lowers the temperature of the metal in the ladle, and this is vital. A foundry foreman had better not use steel at all and keep to his grey iron mixtures rather than attempt to cast steel mixtures at a low temperature. Keep to high temperatures if success is to be obtained, and also remember that the following rule applies:—

Softness to hardness.
Weakness to strength (Tensile).

For transverse strength aim at a lower total carbon with just sufficient Si to keep the combined C. below 0.75 per cent.; if this proportion is increased machining difficulties will arise.

If steel turnings are to be used, it can be done successfully if one charges by weight and sees that the light shavings of steel are kept from blowing up the cupola chimney.

DISCUSSION.

Semi-Steel Firebars.

Mr. Cooper asked whether more coke was required for melting the mixture of steel and cast iron than was usual in ordinary foundry practice. Was that an item of extra cost to be taken into consideration? Was the mixture suitable for heat-resisting castings, such as annealing pots, furnace frames or firebars? Was it worth while to put steel into castings of that description in order to get a superior firebar which would last longer? Could not the quantity of Scotch iron be reduced by substituting No. 1 for No. 3, and would the difference in price be justified?

Mr. Hogg replied that extra coke would certainly be required. He had heard it claimed that textile castings could be produced using 1½ cwt. of coke to the ton, but he had not been able to do that satisfactorily himself. He thought it would take 2½ cwt. per ton to melt iron and steel effectively. A lesser quantity might suffice, but he had seen iron coming down perfectly melted, but with very thin steel shavings imbedded in it, and that was due, he thought, to an insufficient quantity of coke. Before steel could be melted it had to take up a certain quantity of carbon, and it took that up from the coke and the iron in the cupola. If there was not enough coke it did not get the requisite amount of carbon and would not melt.

A mixture of steel and iron he should consider ideal for firebars, because they would have a longer life than the ordinary soft grey iron bars. He had himself cast quite a number.

No. 1 or No. 3 Pig?

He hesitated to say whether there would be economy in substituting No. 1 for No. 3 Scotch iron; it depended on the price. With a reduction of 11 lbs. the same chemical analysis would be obtained associated with the same result.

Mr. Cooper: In my opinion it is more economical to buy No. 1 Scotch than No. 3, not for semi-steel alone, but at all times.

Mr. Miles pointed out that when starting with No. 1 they commenced with a low percentage of combined carbon. What would Mr. Hogg do with scrap that was left over?

Mr. Hogg stated that he would use it for bars and for heavier work such as brackets and pillars. He would mix with it a small percentage of ordinary common iron. It would be satisfactory when it was not intended to machine the casting.

Mr. Miles remarked that very good results were obtained for light machinery castings with the following mixing: Semi-steel shell scrap, 50 per cent., 4½ per cent. silicon pig-iron, 20 per cent., ordinary shop scrap, 30 per cent. But care must be taken that the shop scrap did not unduly increase the amount of combined carbon.

Size of Heads.

Mr. Lyfield asked whether it was necessary to have a bigger head with a semi-steel casting than with an ordinary grey iron casting.

Mr. Hogg replied that if a casting was required to be very dense, it should be furnished with a good head. He would not say that with semi-steel a bigger head was required than with soft grey iron, but he would certainly advise putting a good riser and a good head.

Temperature Considerations.

Mr. Hogg gave the following figures (degrees Centigrade) as showing the appearance of liquid iron: Deep orange, 1,100; clear, 1,200; white, 1,300; bright white, 1,400; dazzling white, 1,500.

Mr. Hogg, replying to Mr. Barnes, said the colour was due to the very high temperature. By putting on a large quantity of coke for a small percentage of iron they would get the metal melted dazzlingly white. He did not advocate pouring into the mould dazzling white, but by the time it got to the mould the temperature would have fallen somewhat.

Mr. Barnes suggested that dazzling white when poured into the mould would result in a sand-burnt casting.

Mr. Hogg agreed, but said the sand should be on the dry side. For a heavy casting the sand should be at least skin-dried. Sand does not penetrate deep into the casting. It would be pitted about the face of the casting. For instance, if a flat plate ½ in. thick is cast, there would be seams all over on both sides, top and bottom. If the sand found its way into the metal it would make dirty castings. Semi-steel was not suitable for ornamental work which did not require any strength. For work of that class he would use the commonest high-phosphorus iron.

Mr. Miles said he thought it had not been made quite clear about the use of scrap. It had been proved when using a mixture of 40 per cent. steel that all the returns could not be used. In one foundry where 35 tons per day were melted, including risers and runners, 12 tons out of the 35 had to be re-melted. After several days it was found to be impossible to use that 12 tons with the 40 per cent. steel, so that it was cut down to 10 per cent. in order to enable all the returns to be used each day.

Mr. Hogg said he used exactly the same mixture. If at the same time he had had orders for ordinary work he could have got rid of the returns. He did not advocate using a high percentage of steel with a high-phosphorus iron.

Mr. Miles: I should say it was satisfactory if the percentage of phosphorus was not above 1.2 per cent. It is being used extensively with pig-iron containing 4 to 5 per cent. silicon.

Mr. Hogg, answering Mr. Barnes, said he thought a ratio of 1½ tons of coke to the ton of iron could be used with a cupola 2 ft. 8 in. dia. melting 10 tons a day. He had himself often melted with 2 cwt. His full blow was 10 or 11 tons, but it depended upon the nature of the work. With very light casting the iron could not be melted satisfactorily with 1½ cwt. to the ton.

Mr. Barnes, referring to a blow of 5 to 6 tons a day, said that before the war his cupola used to average 2½ to 3 cwt. of coke to a ton of metal, exclusive of bed, but now it has risen to 4 cwt.

Mr. Cooper said his work was fairly heavy work, and he used 3¾ cwt. to the ton.

Contraction of Semi-Steel.

Replying to a question as to the effect upon the allowance for contraction, Mr. Hogg said that depended upon the type of casting. With a long pipe, 9 to 10 ft. long, where the combined carbon was very high, there would be a considerable contraction, but in the case of a square or round block

with a semi-steel mixture there was no need to make any difference in the allowance for contraction.

Mr. Beecroft suggested that the amount of carbon would be the same whatever the shape.

Mr. Hogg explained that the total amount of carbon would be the same, but because of the difference in the rate of cooling the proportion of combined carbon would vary. It was difficult to speak dogmatically on these points, for in some cases the contraction might be greater than in other cases. Differences occurred even when the same mixture was used.

Mr. Harwood, speaking on behalf of the engineering students, said the lecture had been exceedingly instructive. In the past the foundry side of the industry had been neglected in technical schools, and he was glad that in Burnley, which they were disposed to regard as a pioneer town, steps had been taken to encourage the education of foundrymen. At all times it was a pleasure to meet a practical man who understood his trade and could explain it, and more could be learned from him than from a purely academic man. The College had a good 25-ton testing machine, and if the engineering department could render assistance in regard to any phase of the craft they would be very pleased to give it. They felt that the foundry people could also teach them something.

The Chairman (Mr. R. Place) said during the war his firm, like most of the others in the town, were engaged upon munitions, and it was absolutely essential for them to experiment with the use of mild steel. Before the war they used to introduce a little hematite into the mixture when the tests of tensile strength were low. The castings were very light. During the munitions period they were not allowed to use hematite for that purpose; therefore they had recourse to mild steel. He regretted that they did not keep records of their experiences, because they would now have been very interesting, but at the time all their energy was given to getting out the work. In the past there had been a lot of secrecy among foundrymen, but the wiser policy was to make known anything that would help the trade as a whole. In that way they would bring back prosperity to the country.

A vote of thanks was accorded to Mr. Hogg, on the motion of Mr. Pell, seconded by Mr. Miles.

Simplifying Cores for Water-Cooled Journal Box.

Mr. M. E. Duggan, writing in a recent issue of the "Iron Age," after emphasising the necessity for co-operation between the foundry and pattern-shop, sets out as an instance the case of a water-cooled journal box here illustrated, which, until

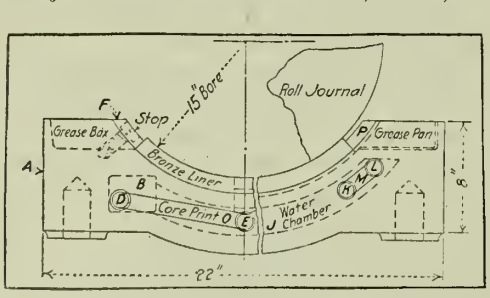


Fig. 1.—The Original Design is Shown on the Left and the Simplified One on the Right.

simplified by the pattern maker, was an expensive experiment.

The original design is shown in Fig. 1. *A* is the casting, *B* is the cored water chamber with a square section as shown, and *D* a $\frac{3}{8}$-in. cored hole leading into the water chamber from both sides. It was intended that these four $\frac{3}{8}$-in. cores (two also in the other half of the casting) would support the body core and provide a means of getting the gas away. This they failed to do, and in addition it was practically impossible to clean out the core sand or to remove the core rods, which caused the moulder to suggest that two more cored holes, as shown at *E*, be added to the casting, and that the core print *O* would assist in getting the gases away besides supporting the core in the mould. While this was true enough, these additional holes weakened the casting so that it broke in service.

The pattern maker then designed the core, as shown in the right. The water chamber **J** is a plain segment of a circle with a larger cooling surface close to the liner, the cored holes (*K* and *L*) are $1\frac{1}{2}$ in. in diameter (instead of $\frac{7}{8}$ in. as before) located near the ends of the cored chamber in the strong section of the casting, and the connecting prints *M* located near the ends and at both sides provide a means of getting the gas out, and are a further support for the body core. The stop *F* is also simplified by making it an integral part of the casting, as at *P*, and a removable grease pan is substituted for the grease box.

Book Review.

Steel Thermal Treatment, by John W. Urquhart. Published by Messrs. Crosby Lockwood & Son, 7, Stationers' Hall Court, Ludgate Hill, London, E.C. Price 35s. net.

In opening this book one cannot help wondering why Chapter I. is entitled "Recent Developments," we feel sure that "Historical" would be nearer the mark, but a deeper consideration of the 70 or more sub-titles certainly does make the choice of heading difficult. The following is a short selection:—The Carbon Group, Burnt Steel, Case Hardening, Cementite, Recalescence, Effect of Excess Heat, Visualising the Heat, Manganese, The Quenching Temperature, Fatigue Effects, Molybdenum Steels. On the whole we do not care for the classification adopted. For instance, "Annealing" has a short defining paragraph in Chapter I., and in Chapter II., entitled Physical Characteristics of Steel, there appears another eighteen-line paragraph, which tells us that "high speed bars are packed with charcoal in tubes, the ends of which are sealed with fire-clay. These are then heated slowly to 1,500 deg. F. (815 deg. C.) and allowed to remain so for about ten hours until about 1,000 deg. F. (535 deg. C.) is reached. This completes the process." We should have thought this was a case-hardening process. Though it is not at all clear what the author means to convey, we feel confident that any interpretation would not give a bar which would be acceptable to the twist drill or milling cutter manufacturing departments. In Chapter III. annealing is again defined. We would suggest that in future editions the centigrade scale of heat measurement be used, as heat treatment is an essentially scientific process, and the bulk of the readers of this book will, in our mind, visualise temperatures by this scale.

Apart from the general arrangement of the book, which does not appeal to us, and several other minor details, we commend the book to the Sheffield tool steel manufacturers, as it contains much of interest for them. They will be pleased to read that iron ores have a profound influence on the properties of the resulting steel. Whilst we do not dispute this, we are always looking for an explanation.

We would point out in the contents list of Chapter XI.—Tools and their Steels—there appears a sub-heading Nickel-Chrome Steels and their Treatment, we rather looked for an innovation, perhaps learning that some combination of iron-nickel-chromium and carbon had been found, suitable for the manufacture of tools. However, no such section actually exists in this chapter.

The book, by the way, contains some 340 pages and is divided into 14 chapters, the last of which is devoted to stainless steel, which is perhaps the most informative section of the book. It is well illustrated with some 136 pictures and diagrams, and should be appreciated by engineers and metallurgists, as it traverses ground common to the two professions.

Views on Mr. Smalley's Paper on High Tenacity Brasses.

Introducing the Paper, Mr. Smalley said his object in choosing the subject was to present to them the possibilities and to discuss and deal with the pitfalls encountered in the manufacture of high tenacity brass, or, as it was commonly termed, manganese bronze. The Paper then treated of the manufacture of pure brass, its physical properties and constitution, and then dealt with a third element, aluminium, going on to tin and manganese, and so forth. The effect of a fourth element was then considered, and had been thoroughly investigated, and then they went on to a fifth element. They would realise that to explore these fields exhaustively one would require a good many papers, and he merely presented to them a general outline of the procedure adopted by their foundries in overcoming the problem of high tenacity brasses, in order to put the manufacturer on a sounder basis and to understand the true functions of the elements introduced. He thought most of them would agree that in high tenacity brasses the number of constituents introduced was so high that they were almost bewildered by the complexity, and hence manganese bronze had got a bad name. This, he was afraid, was largely due to many inventors having appeared to gather as many elements as possible in an alloy. This, then, was really the object of bringing before them this partly synthetic examination of high tenacity brass and bronze. In the second portion he dealt with practical problems of manufacture. Some objection might be put forward that he had only dealt with chilled castings for tests, and they might say that these did not represent sound castings or casting tests. While that was practically true, they must at the same time bear in mind that his investigations in the first place were to find out the effect of the elements introduced, and that could only be done by having a constant area of solidification, and knowing the casting temperature. Had he adopted a sand casting, it would have been impossible to do that.

Lead Content of Brass.

Mr. V. C. Faulkner mentioned that he had recently met a very important representative of an American firm which manufactured a certain amount of non-ferrous material in this country, and he was told that they were buying brass from the States and France, especially light material, because it had a higher lead content than English material, and the latter did not machine up so easily. It seemed almost necessary that lead would have to be introduced in larger quantities for small repetition jobs. Mr. Smalley had said that manganese bronze had a very bad name, but he thought that statement needed some qualification. He believed that it had already established itself as a very excellent material within limits for propellers.

Casting Temperature.

Dr. P. Longmuir said the Paper was one of keen interest to the brassfounder, and he would especially emphasise the author's remarks in presenting the diagram of the constitution of Cu-Zn. alloys (Fig. 1). All high tenacity brasses or bronzes were based on round about 60 copper and 40 zinc, extra strength being secured by small additions to something within that composition. He did not know whether the author had experimented at all on a varying zinc content. Experience had shown that approximately 60/40 was the best; but in practice, especially with air furnace melting, zinc losses did occur. Many years ago they were up against this problem of always having in manganese bronze a constant zinc, and they took lessons from Siemens steel furnaces by sampling their air furnace charges, and, according to the result of the sample, making up any deficiency in zinc. If the zinc kept constant, then constant tensiles ensued, provided the casting temperature was watched. He could hardly agree in fixing a definite 10 per cent.; super-heated casting temperature must vary with the section of the casting. He congratulated Mr. Smalley on his Paper.

Importance of Manganese Bronze.

Mr. G. C. Pierce (London) said he merely wanted to substantiate what Mr. Faulkner had said about the utility of manganese bronze. He was reminded that something like 200 tons per week were put into castings in London alone, and he mentioned this to show that there was a big field for its use.

Mr. Spehring corroborated this statement so far as the dockyards were concerned. All the propellers and 50 per cent. of the metal melted in the dockyards was manganese bronze.

Important Points Indicated.

The President (Mr. H. L. Reason) thought it would be generally agreed that in the short time they had had to consider this Paper, containing as it did such an abundance of information in connection with high tenacity brass, there was a lot that would require a good deal of further study. Mr. Smalley had made it quite clear, and it was corroborated by Dr. Longmuir, that if they were out to make high tenacity brass it could not be done by the ordinary rule-of-thumb methods of the brassfounder. In making ordinary brass alloy or bronze alloy they had carefully to watch their constituents and their losses, and also watch very closely their pouring temperatures. If one was inclined to think that these alloys could be taken up haphazard and get good results, disappointment was bound to follow. But Mr. Smalley had pointed out quite clearly that if they watched the point he had referred to they ought not to have a great deal of difficulty in obtaining good and regular results. Looking through the totals and the results obtained by different alloys, they would notice that the increased yield point and tensile had invariably been obtained by a loss on the elongation. The increased yield point and tensile, or the figures that Mr. Smalley gave, were of course high, due to the fact that they were chill-cast. They must not expect to get these results in an ordinary sand cast, for, as Mr. Smalley pointed out, in making research of this description and giving reliable results, he was bound to have a fixed rate of cooling, and he must compliment him on the step he was taking in that direction. By having a fixed rate on permanent moulds Mr. Smalley had been able to place before them most reliable data. As an example of what took place by raising the yield point and elongation, if they examined Table 2 (page 12 of the Paper), and compared No. 9 with No. 11—he thought it was No. 9, without referring to the Paper—that No. 11 gave the highest tensile of the 42 alloys that had been dealt with. It would be surprising to those who had not studied the Paper to know that the author had given the result in his Paper of no fewer than 42 distinct alloys. In the one which gave the highest tenacity they found the lowest elongation, 3 per cent.; but in No. 9 there was a considerable drop in the yield point and tensile. But they would notice that for that corresponding drop there was a considerable increase in the elongation, and he thought Mr. Smalley would agree that, generally speaking, for copper alloys, an alloy that would not give them 15 to 25 per cent. elongation was really too hard and brittle for commercial use. The alloys that appealed to him, and should be considered in conjunction with the results in Table 1a, were 70/30, 59/41; for standard commercial alloys he should pass to Table 2 and mark Nos. 11, 9, A2, and A4; and then to Table 5 he should number F2, Table 9 AM4, and Table 10 AM3C and AM3D. Mr. Smalley had confined his attention to what he (the speaker) should term brass. Although he headed his Paper "High Tenacity Brass and Bronze," he hoped they would pardon him for saying that he thought it was distinctly high tenacity brass. He hoped that at some future date the author would have the opportunity of conducting a similar investigation in connection with brasses with a copper content from 85 to 88, and show the effect of tin, zinc, lead, nickel, manganese, aluminium and iron. He could strongly support what Dr. Longmuir had

said, that this was one of the best Papers given on high tenacity brass, and, as an Institution, they were very much indebted to Mr. Smalley for his investigation, and for giving them the results.

The Author's Reply.

Mr. Smalley, in reply, agreed with Mr. Faulkner that lead was very necessary in these alloys; but he had not considered lead, because he thought he had gone far enough. However, as far as its effect on the physical properties went, he thought he could say that on ordinary manganese bronze, lead had no appreciable effect up to 0.75 per cent., and they would be safe in using that quantity. If they went beyond that, they would be limited by the test results as to what they required. Mr. Faulkner had perhaps misunderstood him in regard to the usefulness of manganese bronze. He did not wish to imply that it was an unreliable material; what he meant was that he had seen so many papers on manganese bronze with a condemnation of it by various engineers in the past, and it was to this he referred rather than to the position of manganese bronze to-day. Thanking Dr. Longmuir for his kind remarks, Mr. Smalley said, as the Doctor pointed out, absolute precision and control of composition was a first essential in the manufacture of these alloys. He would not do it by the zinc content; he did it preferably by structure, because in having control of the structure they controlled their properties to a more reliable degree. For if they introduced various elements which had high zinc equivalents, then they exercised a much more important effect than zinc. For example, aluminium was six times as efficacious as zinc, silicon ten times, magnesium 2½ to three times, and so forth; and so in a complex alloy they must have precise control of the composition. Mr. Pierce had referred to the important use of manganese bronze, and he (the speaker) confirmed that, and quite agreed it was a very successful material.

Some Notes on Semi-Steel and Loam Moulding.

In connection with Mr. Cameron's Paper on "Semi-Steel," Mr. Thomas Bell wrote that he was very sorry so little time could be allowed for discussion of the very excellent Papers presented to the Conference. He had expected to hear some remarks from some of the practical men regarding the use of semi-steel for the heavy class of castings, and he was anxious to get some information as to its use for same. In the addendum some useful information is given; still, he could have wished for some information as to the method adopted in keeping the metal hot in the ladle when a large quantity is required and can only be drawn off in three or four taps. Another point which is always well discussed is the form of the graphite for high-tensile tests. It would have been of great interest to the practical men to have had some information how to get the graphite in this fine divided form. He supposed casting temperature would have something to do with it. Could this be regulated? He was delighted with Mr. Cameron's Paper, and if he or any of the members who took part in the discussion can offer any further information on these points he, as one of the practical men, would watch The Foundry Trade Journal with interest for same.

Regarding Mr. Varlet's Paper on "Loam Moulding," he would like to support in a general way the remarks of Mr. Gallon on the class of apprentice taking up loam moulding, and would ask Mr. Varlet if he has always found the moulding of the marine cylinder with the feet or stools down the best method, as it is very general in Scotland to cast marine cylinders with the feet or stools on top. We are enabled to run from the top by dropping a number of gates straight down the barrel thickness. He had very seldom seen a clean casting run by the gating system shown by Mr. Varlet. Slag invariably gets in by this system, but it is possible the slag may be floated up into dirt head shown. He was afraid very few would risk running a cylinder in the manner shown. He would thank Mr. Varlet for his very interesting "History of Loam Moulding in the Province of Liège."

Concerning Machine Moulding.

By J. J. Atkinson.

The invention of the spinning machine by Richard Arkwright, afterwards Sir Richard Arkwright, is common knowledge to all who are mechanically interested or inclined and to many others, too. How, when 36 years of age, in the year 1768, he erected his first machine at Nottingham and had a hard battle to fight, how his first mill was destroyed at Chorley, how men and masters were hostile to his invention, and how protracted litigation greatly vexed him, and after all, how in the end his triumph was pronounced. This, of course, is history of a century and a half ago, but it is none the less true, in this as in other history that repetition has occurred, as has been seen in the attitude of moulders within recent years to the advent of machines which from the commencement were bound to come into their own.

Nor need it be imagined by present-day moulders that machine moulding is an invention of the last two or three decades; the writer remembers reading a book published by Messrs. Howard, of Bedford, in which a description is given of a machine they made for moulding some of their manufactures at least 50 years ago.

Perhaps in no branch of industry has there been greater reluctance to employ modern machinery than in the foundry, and the fault does not altogether rest with the employees. It is not suggested that foundries should purchase every so-called labour-saving device that is put upon the market, but there are, without doubt, several instances where a little capital expended judiciously would have proved a good investment.

One of the reasons which has operated against the success of the moulding machine is that the whole question has not been thoroughly considered before the actual introduction of the machine. The points to be remembered include the variety of work to be handled and the quantities, as the latter will determine whether an elaborate or first-class moulding machine will be justified or not.

The type of machine, whether hand- or power-operated, should also be very carefully considered, as this is important. For example, with the hand-operated machine, the class of work, the output desired, the type of machine, and the number and type of boxes must be studied in advance, together with the question of whether the working is to be by skilled or semi-skilled labour. It must also be remembered that in very plain work, handled on squeezing machines, so-called semi-skilled labour rapidly becomes unskilled, because the pattern is free from stripping troubles, if carefully made free from undercutting and with a definite though not an extravagant taper.

Similar conditions operate with power machines, as the skilled work is done by the pattern-maker, but it presents additional questions. The machine itself is more costly, added to which there is a compressor plant, if air is decided upon, or an accumulator if hydraulic power is adopted. Either demands pipe-lines and fittings. Additionally, there is the power-plant labour, the power for driving the air-compressor, the cost of lubricating oil, water, and repairs.

One or two hand-machines, however, if not required for some time, can be well-greased and set aside with very little overhead charge, which would be difficult with power machines and plant.

The successful working of moulding machines depends very largely on the enthusiasm displayed by the foreman moulder and patternmaker. Unfortunately, the purchase is sometimes made by the manager without taking his foreman into his confidence, and it is only after he finds his purchase unsatisfactory that he sees his mistake. Such conditions are greatly to be regretted, as the opinions of persons who are so closely connected with the working of any machine are surely worthy of cultivation.

The first cost of such machines is very often an obstacle to the foundrymen, but it should be remembered that these are now high-class precision tools. They require to be taken the same care of as machinery in a production engineering shop, and not as shovels and riddles, which in the foundry are usually very badly handled.

Prof. Touceda's Paper on Malleable Iron Discussed.

Dr. P. Longmuir welcomed the author of the Paper on behalf of the Institution, and congratulated him on the very complete records that he had given of American foundry practice.

American Malleable Iron Practice.

Mr. F. J. Cook (Birmingham) added his testimony, having just returned from the States, as to the high efficiency of the malleable products of that tremendous country. He must say, however, that his experience with regard to grey iron was most disappointing. Still, the pleasure and interest it gave him to see what the malleable industry was doing more than compensated for any loss in other directions, and the improvement of the malleable iron industry was mainly attributable to the work of Professor Touceda.

Mr. O. Stubbs (Manchester) thoroughly agreed with what Mr. Cook had said. Production in the States was enormous. He had the privilege of going over the biggest malleable iron foundries in America, and the first he went through had a weekly production of 2,000 tons. They were very much in front of British foundrymen as regards malleable iron. The question of interior transport was also a matter of first consideration out there. They did not find a workman wheeling a barrow; everything was done mechanically, and this principle was carried right through. There was no doubt that the Americans were producing a very fine malleable casting. He had the pleasure of meeting Professor Touceda in New York, and he could assure him that they all felt very much honoured by having the opportunity of welcoming him now in person. Indeed, he might say that they had with them that day the highest brains in the malleable iron industry.

Mr. S. Flagg (America), as a member of the Association of which Professor Touceda directed the technical side, said he could not refrain from giving evidence of the high value they put upon Professor Touceda's services. Those familiar with recent published tests of elongation would be interested in his work in this respect. Early in 1914 he saw tests in this country giving 17 per cent., but in work done under the Professor's direction 17 per cent. was considered very low. They would see in his Paper 25 to 30 per cent. elongation as an actual accomplishment under his direction.

Prof. Turner (Birmingham) joined in welcoming Prof. Touceda, and said it had been his pleasure for the last seven or eight years to read Papers, particularly in the Journal of the American Foundrymen's Association, contributed by him. No doubt this succession of Papers had contributed very largely to their knowledge, and Prof. Touceda, by these published results of investigations, had been instrumental in greatly improving the quality and uniformity of the product in the United States. He did not now propose to discuss the technical matters embodied in his Paper, but he might say he had been struck by the fact that he referred particularly not only to the lay-out of the plant, but to the heating of the foundry, the comfort of the workmen, and the lighting conditions. These were matters which did not receive the proper amount of attention very often in this country. If they were to get the best work out of the men they must be able to work under conditions which were comfortable, and to see properly what they were doing. Part of the Paper, which he had not heard before, touched on a matter relating to the effect of chromium. This raised an extremely interesting theoretical and practical question. There were many pig-irons that contained small quantities of chromium and of nickel, especially those melted from Cuban ores and other ores from the States.

Scientific Gating Advocated.

Mr. Retallack (Willenhall), speaking of the means of transport in American foundries, said the way they handled material up to 60 and 70 ton loads was remarkable. He also urged the adoption of a policy of scientific gating, relative gating according to the section and size of the casting.

Mr. Miller inquired if Prof. Touceda had considered the use of English irons with regard to making black heart castings. A good deal of work was done there in the making of cycle fittings, which in this country were brazed.

Mr. Wilkinson (York) said some of the results obtained by Prof. Touceda were an eye-opener as to the possibilities of malleable iron. Nothing approaching them had come under his notice before in regard to elongation. Alluding to pages 48 and 49 of the Paper, as to the elasticity of castings (headed "Composition Limits"), he said that, having made many thousands of these castings, he must admit that the practice in America differed considerably from the practice here.

Mr. J. E. Fletcher (Dudley) described the Paper as wonderful in its information and scope. The diagram of a melting furnace (Fig. 3) on page 22 of the Paper reminded him of the practice in America of melting heavy masses of metal for malleable cast iron. He thought they were often forgetful of the fact that their American friends were able to follow that practice because of their tremendous output, and these methods placed them in this country at once in quite a different position from the States. Looking at the details of the furnace shown in the diagram, they would see that here the flame effect was able to carry out its purpose efficiently; whereas in their British foundries, even though making black heart malleable, their output was so small that they had to use shorter furnaces, and could not obtain that efficiency of melting that undoubtedly was possible in America. He considered that they ought to be specially grateful to Prof. Touceda for pointing out these phases of malleable iron manufacture. Here they were confined to small crucibles or cupolas, or in some cases small gas melting furnaces; but they were on entirely different lines from those used in America. He assumed that Prof. Touceda would tell them that during the process of melting in these large furnaces a considerable amount of oxidisation took place, which helped towards refining it; it assisted in getting a low carbon metal. Another point which might be noticed by practical men was the position of the running spout in the air furnace. Those who had used furnaces knew how vital this point was, and how serious was the mistake of putting the spout in the wrong position. Emphasising the difference in output of American and British foundries, Mr. Fletcher said that as long as they had small furnaces it was going to be very difficult indeed for them to obtain those high elongations which Prof. Touceda had mentioned. But those interested in the advancement of research and scientific means of working with malleable iron were greatly indebted to him.

CONCRETE FLOORS IN FOUNDRIES.—Judging from the evidence of men who have used concrete floors in foundries for years the question of whether the surface of the floor will spall when molten metal is spilled upon it is not serious. It would be well, however, to avoid the use of granite or quartz gravel aggregates in the construction of such floors, because those materials do not stand heat as well as certain other aggregates. Trap rock possibly makes the best aggregate for resisting heat, and slag, limestone, or limestone gravel may be used with excellent results.—"Brass World."

Employment in July.—The Ministry of Labour report that employment during July showed a slight improvement as compared with June. The percentage unemployed among members of trade unions from which returns are received was 14.6 at the end of July, as compared with 15.7 at the end of June, and 16.7 at the end of July, 1921. The percentage unemployed among workpeople insured under the Unemployment Insurance Act was 12.3 at July 24 as compared with 12.7 at June 26. The total number of workpeople registered at the Employment Exchanges as unemployed at July 31 was approximately 1,400,000, of whom 1,151,000 were men and 170,000 were women, the remainder being boys and girls. At the end of June the number on the live register was 1,455,000, of whom 1,206,000 were men and 177,000 were women. The number of vacancies notified by employers to exchanges and unfilled at July 31 was 14,100, of which 2,800 were for men and 9,200 for women, compared with 16,500 at June 26.

Discussion on Prof. Campion and Mr. Donaldson's Paper on Strength of Cast Iron at Low Temperatures.

Results on Casting.

Mr. Young remarked that if the figures adduced did not agree with their theories it did not so much matter, as the authors had given them these figures showing the result of their work without drawing their conclusions, and left it to them to use what they had discovered. This Paper was just the type the Institution wanted. The greatest compliment he could pay the authors was that he hoped they would go on with it.

Prof. Turner agreed that the Paper contained so much detail that they could scarcely criticise it in a few minutes. It opened up a new field of work, although they had been told others had been working recently in the same direction. They might regard this Paper as filling in a space in the work of Dr. Carpenter in connection with the effect of what he called high temperatures. They had not hitherto had information on cast-iron at those temperatures at which it was used in connection with superheated steam. They did know about the behaviour of cast iron where they had red heat and beyond, for such things as fire bars, etc. But the information contained in this Paper filled in the space and supplied what was required. It would be a matter for thought and consideration as to the explanation of the effect of annealing upon cast iron. They might suppose that castings which had been allowed to remain in sand and to cool in a normal way would have annealed themselves, and that the annealing at so low a temperature as 300 to 400 deg. C. would not make any appreciable difference. Apparently that was not the case, and there was an appreciable difference due to this annealing. All kinds of suggestions might be made as to the reasons for the effect of 300 deg., and so on, because they obtained a somewhat similar effect in connection with some of the carbon steels. There was an absence of theory from the authors, and he thought further consideration would tell them the right theory. But for the time being, as Mr. Young suggested, it was well to accumulate more facts of the kind which the authors had been good enough to place before them.

Shrink Due to Low Temperatures.

Prof. Touceda mentioned that he had conducted a great many experiments to remove shrink, their idea being to make a study of the amount of shrinkage caused by low temperatures.

Dr. Johnson expressed towards the authors of the Paper his great admiration for the careful and scientific manner in which they had carried out their experiments, and he would like to ask whether they intended, in their continuation of the work, to include microscopic work and other kinds of mechanical and physical tests, such as hardness and impact tests. The Institute was fortunate in having such a Paper presented to its members, containing an account of careful scientific research of such high character.

Dr. P. Longmuir, in congratulating the authors upon the excellence of their work, said they were favoured the previous night by a very good description of the original research. That morning they had an example that fitted in with that description given by the Principal of Birmingham University

Mr. Matt. Riddell, invited to wind up the discussion, said he had seen some of the details and the material worked out, and considered the authors had done something really splendid for the information of that meeting. It was something they had been looking forward to for a long time—a piece of real original research. Prof. Campion was a man trained to do research work, and knew more on the subject of cast iron than almost anyone else. He had special facilities for carrying on his work, and also had the necessary practical experience; and if he could be persuaded to continue in this research work he was confident that Prof. Campion would furnish them with valuable information at present unknown. Alluding to the diagrams showing some change at 400 to 500 deg. C., Mr. Riddell said there must be some important factor in operation in the iron at that particular temperature which required investigation.

The Authors' Reply.

Prof. Campion, in reply, thanked the Conference for the kind way in which they had received the Paper, and also acknowledged the contributions made to the discussion. He quite realised that in a few minutes it was practically impossible to discuss such a Paper, because it was very difficult to digest. He trusted that those who had not been able to speak would send written contributions to the General Secretary, and assured the meeting that he and his colleague would be glad to consider them, and also to reply to Dr. Longmuir, if he would do likewise. Mr. Young had referred to other results which confirmed more or less several results they obtained. Prof. Turner raised the question about possible theories. They had given none in the Paper, because they felt they had not done sufficient work to put forward any theory. It was a very complex problem, and showed distinctly different phenomena from that which occurred at high temperature work, such as Dr. Carpenter carried out. It therefore wanted very careful consideration and far more tests and experiments than they had been able to carry out or analyse. In that respect he might also answer Dr. Johnson, for they had already done a very large amount of micro examination, thermo and other mechanical tests. But the Paper was already loaded, and he thought it was unwise to give too much at once. However, another Paper was in course of preparation for another Institution, which would be presented shortly, and he would be glad to forward to Dr. Johnson, or any gentleman present who desired it, a copy of that Paper when it was presented, and have their criticisms on it. Prof. Turner's remarks were interesting, because he did think that the question of recording casting temperatures had a direct bearing on the behaviour of these metals when heated and cooled at these low temperatures. Some preliminary experiments pointed emphatically to the fact that the amount and nature of the gases included in the iron largely affected the results; and this was largely the explanation of some of these metals beginning to contract instead of expanding when heated.

Mr. Donaldson also replied briefly, saying that they had carried out a considerable amount of work in addition to what was published, particularly in relation to the change of strength after heating and cooling, as dealt with on page 12 of the Paper. But they did not want to publish it, because they had not got to the end of their tests on annealing. He might also say, as to continuing on the lines of work undertaken, that they intended to go on testing those irons with the addition of special elements to see what effect those special elements had on cast iron, chromium, and so forth.

Iron and Steel Output in July.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in July amounted to 399,100 tons, or nearly 30,000 tons more than in June, but nearly 9,000 tons less than last May. The July output included 111,400 tons of hematite, 147,100 tons of basic, 91,000 tons of foundry, and 21,000 tons of forge pig-iron.

The production of steel ingots and castings amounted to 473,100 tons, a figure only once exceeded since the resumption after the coal stoppage, viz., in March, when production was 549,400 tons.

The average monthly output of pig-iron was 217,600 tons in 1921, 669,500 in 1920 and 855,000 in 1913. The corresponding figures for the output of steel ingots and castings were 302,200 tons, 755,600 tons and 638,600 tons respectively.

MOULDING SAND RESEARCH.—The American Bureau of Mines, which is co-operating in a general research on foundry sands, organised by the American Foundrymen's Association and the National Research Council, is now collecting data on sands for moulds and cores in aluminium-alloy foundry practice. A questionnaire is being sent to aluminium-alloy foundries to obtain data to be used in the preparation of a report.

American Specifications for Semi-Steel Castings.

New tentative specifications for high-test grey iron castings, familiarly known as semi-steel, were adopted by the American Society for Testing Materials, at the Atlantic City Convention. They are as follows:—

1. These specifications cover all classes of grey iron castings which are required to have a high strength, including those generally known as semi-steel castings.

2. The tension test will be made only when specified by the purchaser and at his expense.

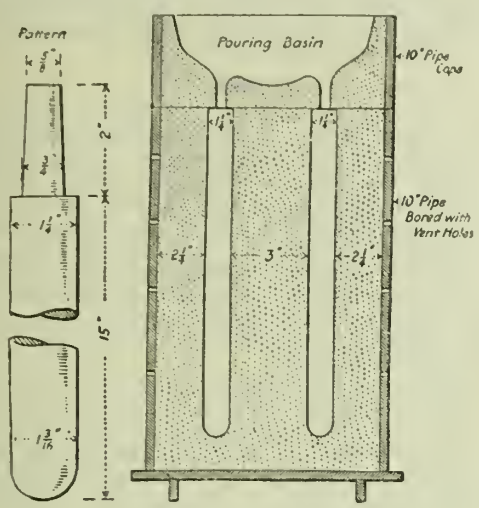


Fig. 1.—Mould for Arbitration Test-bar.

Manufacture.

3. The castings may be made by the cupola, or any other approved process.

Physical Properties and Tests.

4. (*a*) The transverse test specimens (arbitration test bars) specified in Section 6 (*a*), when placed horizontally upon supports 12 in. apart and tested under a centrally applied load, shall withstand a minimum load of 3,800 lbs. and deflect under this load at least 0.12 in. at the centre.

(*b*) The rate of application of the load shall be such that a central deflection of 0.10 in. is produced in from 20 to 40 sec.

5. When tension tests are specified, the tension test specimen shall show a minimum tensile strength of 28,000 lbs. per sq. in. (12.5 tons).

6. (*a*) *Arbitration Test Bar.*—The form and dimensions of the mould for the arbitration test bar shall be in accordance with Fig. 1. The bottom of the bar shall be 1-16 in. smaller in diameter than the top, to allow for draft and for the strain

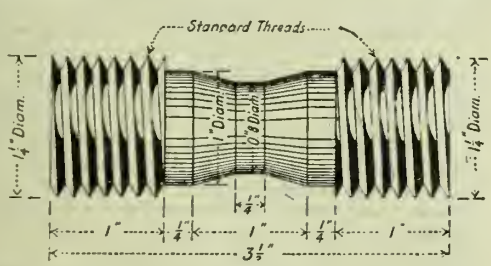


Fig. 2.—Tensile Test-piece for Semi-Steel.

of pouring. The pattern shall not be rapped before withdrawing. The flask shall be rammed up with green moulding sand, a little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mould shall be rammed evenly and fairly hard, thoroughly dried, and not cast until it is cold. The test bar shall not be removed from the mould until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

(*b*) *Tension Test Specimen.*—When tension tests are specified, the tension test specimen shall be turned from any of the broken pieces of the transverse test specimens, and shall conform to the dimensions shown in Fig. 2.

7. (*a*) Two sets of two arbitration test bars each shall be cast from each melt, one set from the first and the other set from the last iron going into the castings. Where the melt exceeds 20 tons, an additional set of two bars shall be cast for each additional 20 tons or fraction thereof. In case of a change of mixture during the melt, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars shall be cast in a single mould.

When a large casting is made for which test bars are required, the test bar shall be cast from the same ladle of iron used to pour the casting. If two ladles are used for pouring the casting, the iron for the test bars shall be poured from a ladle of iron caught between the pouring of these two ladles. In either case the test bars shall be poured at as near as possible the same temperature at which the casting is poured.

(*b*) All arbitration test bars shall be tested as specified in Section 4 (*a*).

8. One arbitration test bar of each set cast shall conform to the requirements specified in Section 4 (*a*); otherwise the castings represented by such bars shall be rejected.

Workmanship and Finish.

9. The castings shall be true to pattern and free from gas holes, cracks, flaws and excessive shrinkage. In other respects they shall conform to whatever points may be specially agreed upon between the manufacturer and the purchaser.

Inspection.

10. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

"The Story of Steel."—A six-reel cinema film illustrating the process of steel-making has been produced under the auspices of the U.S. Bureau of Mines and the U.S. Department of Commerce in co-operation with the United States Steel Corporation. It will be used extensively in the United States and abroad for the purpose of showing the many interesting operations employed in the American steel industry. The film will be loaned without cost to all dependable persons desiring to use it for educational purposes. Application should be made to the U.S. Department of Commerce, Washington, D.C.

Luxemburg Iron Industry.—In the course of a not very favourable annual report, the Luxemburg Chamber of Commerce states that although it had been possible in some cases successfully to work the French market, this is now no longer possible in consequence of the raising of the import duties. Belgium offers but few possibilities as a market for the Luxemburg iron industry, while the prices prevailing in Germany, together with the low costs of coke and wages, excluded any prospect of successful business in that country. Under the circumstances, the report states, there is nothing left for the Luxemburg industry but to cultivate overseas markets, as, for instance, Brazil, Argentina, India and Japan; and the sales offices already established in these countries have been further developed. Complaining rather bitterly that Luxemburg industry "has been forced into a subordinate position in the world's markets in relation to those countries who are unfavourably situated financially, and who receive subsidies from wealthy Governments and give orders in return," the report concludes with the remark that as this is out of the power of the Government of Luxemburg, the native industry has to take care of itself in this respect.

The Analysis of Cupola Slag.

By "Celsian."

Few methods have been given in text-books for the rapid estimation of iron when conducting the analysis of slags.

In the analysis of slags from non-ferrous metals, care is usually taken that the constituents are so separated that more than one can be estimated at a time, thus economising the time expended. This has seldom been attempted when cupola or other iron slags are dealt with. One of the obstacles to rapidity usually encountered is the difficulty in bringing the slags into solution, as many of them require a preliminary fusion with potassium and sodium carbonates and other fluxes.

Rapid methods of dissolving slags in special acid mixtures have been worked out by several chemists, but usually little has been heard of the results obtained. The following method gives details of a rapid means of separating the constituents of the slag after the latter had been dissolved.

Method.

This method may be applied when dealing with cupola, blast-furnace or steel (acid and basic) slags. The powdered sample of slag is weighed out and mixed with a fusion mixture composed of equal parts of sodium and potassium carbonates and about 10 per cent. potassium nitrate. This material is fused in a platinum crucible in muffle furnace, and the fusion when cold is extracted with water and a little hydrochloric acid. As the solution is to be evaporated to dryness, the least possible quantity of water and acid should be used. Where the slag is soluble in acids, it is boiled down to a low bulk with hydrochloric acid and a few drops of nitric acid. Further details of the methods used for dissolving the slag may be had from most text-books on analysis.

To the solution containing the dissolved slag and free silica, add sulphuric acid, evaporate the liquor to dryness and bake the residue on a hot plate. After cooling, add a few drops of sulphuric acid and take up in boiling water, filter, and wash the mixed precipitate of calcium sulphate and silica till free from acid. The addition of alcohol to precipitate completely any remaining traces of calcium sulphate is scarcely necessary when dealing with a concentrated solution. The precipitate is then digested in a hot, strong solution of ammonium sulphate.

Calcium sulphate is soluble in the latter reagent, but the silica is left unaffected. The solution is filtered and washed, and the precipitate ignited and weighed as silica. The best results are secured by filtering the solution hot, and washing first with hot ammonium sulphate solution and then hot water.

A method has been suggested whereby the mixed precipitate of silica and calcium sulphate is first weighed on a tarred paper, after which the latter is washed out with ammonium sulphate and the silica ignited and weighed. By this means the percentage of lime can be obtained by difference, but in some instances the dried calcium sulphate is not rapidly soluble in ammonium sulphate, so that a great deal of time is often wasted.

Lime.

The calcium sulphate is quickly re-precipitated by boiling the solution with a little sulphuric acid and adding about 10 c.c of alcohol before filtering. When little lime is present the solution requires to be settled before filtering; double-ribbed filters should be used. The precipitate is washed with water containing a little alcohol and the mass carefully dried and detached from the paper. After burning off the paper, the precipitate is added to the crucible and carefully ignited and weighed as calcium sulphate, from which the calcium can be calculated. Care must be taken that no reduction takes place at too high a temperature in presence of any unburnt carbon of the paper, as the calcium sulphate may be partly converted to sulphide. The filtrate contains iron, aluminium, magnesium, and small quantities of phosphorus and manganese. The last two and the sulphur are much more rapidly estimated in a separate sample of the slag.

Alumina.

To the filtrate from the lime-silica precipitate, add ammonium chloride and hydrochloric acid, and then neutralise the excess acid with sodium carbonate solution. Add a strong solution of sodium thio-sulphate in such quantity that it reduces all ferric salts to the ferrous state (the solution being rendered colourless). A further addition of thio-sulphate is made, and the solution boiled till free from sulphur dioxide fumes. The hyposulphite is decomposed and aluminium precipitated as hydroxide. Filter the solution, wash with hot water, dry, ignito, and weigh as alumina.

Iron.

To estimate the iron by the sulphide method is the most rapid, but as the remaining filtrate requires to be boiled for some time to free it from sulphide fumes, and a very large, bulky precipitate of sulphur requires to be filtered off, the estimation of magnesia is slower, and more time is required in the long run. The method of measuring the solution, dividing into equal halves, titrating the iron in one portion by dichromate or permanganate, and precipitating magnesium in the other is rapid, but cannot always be relied on to give accurate results.

Another method often adopted consists of oxidising the iron with nitric acid, and precipitating it with ammonia and ammonium chloride, after which the magnesium is precipitated by the usual phosphate method. As the iron has been reduced to the ferrous condition, use should be made of it in this state instead of reducing it, as a great deal of time is lost here unnecessarily.

The following method, although not giving very accurate results with the magnesium estimation, can be relied on to give a rapid approximate assay which is sufficiently accurate for all ordinary works requirements. The solution, after boiling with hydrochloric acid to decompose the excess hyposulphite, is titrated directly with standard potassium dichromate solution and the percentage iron oxide computed.

To the titrated solution, which is still hot, add a few cubic contimetres of strong suphurous acid solution. A green coloration will be formed if the dichromate has been reduced, it should be boiled for a few minutes to effect complete reduction. An excess of ammonium carbonate is then added, and the solution filtered and washed. Ammonium carbonate precipitates chromium and iron, the former as hydroxide and the latter as ferrous carbonate, while magnesium remains in solution, as there is an excess of ammonium chloride present.

Magnesia.

The magnesia is estimated in the usual manner by adding excess of ammonia and ammonium phosphate, stirring, settling, filtering, drying, igniting and weighing as pyrophosphate. Accurate estimations of magnesia are seldom if ever conducted in ordinary works laboratories. To secure the best results the filtrate containing the magnesia should be evaporated to dryness and bakod until all fumes of ammonium salts have been evolved. The cooled residue is dissolved in a little hydrochloric acid, treated with a moderate excess of ammonia and the magnesia precipitated with a sodium "hydrogen" phosphate solution after which it is allowed to settle for several hours before filtering.

In comparing the foregoing methods of estimating iron and magnesia with the standard methods, it should be remembered that the latter are not always adopted in works laboratories, modified analysis being generally preferred, which produce results in a shorter time. Any small quantity of the alkalies in the slag is estimated in the filtrate by the usual text-book methods.

Manganese and Phosphorus.

Another sample of the powdered slag is weighed out and mixed with the same fusion mixture as before. Fuse in a platinum crucible, and after cooling dissolve out the mass with distilled water. No acid should be used here unless the mass shows

signs of great insolubility, as it causes part of the silica to separate out. The solution is measured and divided into equal halves, or portions of known volume. To one portion add about an equal volume of concentrated nitric acid and heat to boiling-point. Add a few c.c.'s of a dilute solution of silver nitrate and then several grammes of ammonium persulphate. The nitric acid causes part of the silica to separate out, but it has no detrimental effects on the colour produced by the manganese. The solution is boiled on a water bath until the pink colour is fully developed, cooled rapidly and titrated at once with a standard solution of sodium arsenite until the colour disappears, leaving the solution tinted pale green.

Where little manganese is present, the colorimetric method may be applied, but the solution must not be filtered, as the silica is only incompletely precipitated and not granular, so that there would be a risk of it sticking in the filter. The titration with sodium arsenite is to be preferred to the colorimetric method.

Phosphorus is estimated in the other portion of the solution by applying the colorimetric method, as the ordinary gravimetric and volumetric assays could not be successfully used unless the silica was removed, which would take some considerable time. An excess of ammonium hydrate is added to the solution, together with a little ammonium chloride. The thick iron sludge is re-dissolved in nitric acid, heated to about 70 deg. C., and an excess of a 10 per cent. ammonium-molybdate solution added. After shaking well and warming on the hot plate, the yellowish liquor is transferred to an ore glass and compared with a standard phosphorus solution prepared in a similar manner.

The manganese and phosphorus can thus be estimated without resorting to the prolonged method of separating the silica first. The same procedure requires to be adopted for estimating manganese and phosphorus when dealing with slags soluble in acids, with a few exceptions.

In dealing with slags containing iron in both ferrous and ferric conditions, the ferrous oxide may be estimated in a portion of the liquor from the second fusion, in which cases the fusion mixture used must be free from nitrates or other oxidising material.

Manipulation.

In conducting the foregoing analysis the two fusions are carried out together. The manganese and phosphorus assays are completed while the silica is igniting. The iron is estimated and magnesia precipitated while the alumina and lime precipitates are being dried. The magnesia is settled and filtered while the latter are being ignited and weighed. The magnesia is weighed last. By conducting the analysis in this manner the method will be found to be much more rapid and practically as accurate as the ordinary methods of analysing slags.

The shipbuilding prospects of the Tyne are rendered slightly more hopeful by the receipt of instructions by Hawthorn, Leslie & Company, Hebburn, to proceed with the construction of two large passenger vessels, which, it is understood, are for the British India Company.

A conference of Local Authorities interested in the opposition to the application of the Cumberland Waste-Heat Owners' Company, Limited, to the Electricity Commissioners for a special order in respect of the urban districts of Egremont and Cleator Moor was held at Whitehaven last week. The Authorities represented were the Whitehaven Town Council and Rural District Council, Cleator Moor, Egremont, and Arlecdon and Frizington Urban District Councils. After the matter had been fully discussed, it was resolved that there be joint opposition by the respective Authorities concerned.

Following Industrial Court proceedings and an award in relation to the wages of railway shopmen, Sir Henry Fowler, representing the railway companies, has intimated to the trade unions concerned the urgent necessity for the following reductions: 5s. 6d. per week from July 31, 5s. from August 28, and a further 5s. from September 28. Sir Henry has informed the unions that the railway companies claim that the reductions now being put into operation in the engineering industry should operate also in the railway shops. The matter is being referred to the Executives of 28 unions to be dealt with from a national standpoint.

Malleable Castings.

The great improvement in the quality of the malleable iron castings during the past few years is dealt with in a booklet entitled "Certified Malleable in Transportation and Industry," just issued by the American Malleable Castings Association, Cleveland. It is asserted that less than 10 years ago there was little definiteness to the physical properties of the malleable iron and that there were virtually as many varieties as there were foundries making it. Co-operative efforts were started in 1913 by the 25 members of the Association, which has since increased its membership to 50. Through these efforts, it is stated that the manufacture of malleable iron has been changed from a hit-or-miss proposition to a scientific basis.

When the research work was started, with a view of improving the physical properties of malleable iron, members were required to submit test-bars daily. At that time the specifications of the American Society for Testing Materials for malleable iron called for a tensile strength of 17 tons and 5 per cent. elongation in 2 in., but this specification exceeded the product of many foundries. Through individual plant inspection the adoption of more successful practices and the regular submission of test-bars, it was not long before a majority of the malleable foundries were making castings exceeding the A. S. T. M. specifications, and subsequently, at the solicitation of this Association, these specifications were raised to 20 tons tensile strength and 7½ per cent. elongation in 2 in., this specification being later adopted by the Society of Automotive Engineers. The Association was inspired by its success to further improve its products, and as a result a new specification of 22 tons per sq. in. tensile strength and 10 per cent. elongation has been adopted recently. It is pointed out that other desirable properties have shown even greater improvement. Experiments have been conducted to develop soundness, machining qualities and finish. The use of chills has given way to a proper proportioning of gates and risers, so that voids due to unequal cooling of the metal may be eliminated rather than driven to other parts. Sealed castings have been eliminated by the proper selection and treatment of packing materials and the proper protection of casting during annealing.

Role of the Microscope.

The practice of issuing certificates of merit to foundries whose products meet the rigid requirements of the Association, from which developed the term "Certified Malleable Castings," is described, as well as some of the manufacturing processes. The microscope is given credit for accomplishing much in bringing malleable castings to their present high standard of quality. It is stated that one of the most popular fallacies regarding malleable castings was the belief that the valuable properties of the castings is confined to its surface, and that it has a tough outer skin with a hard brittle interior. It is pointed out that a study of the better malleable casting with the use of the microscope revealed that malleability was not due exclusively to the decarbonising effect of the packing material, but rather to the breaking up of the hard carbides and the formation of ferrite or carbonless iron, the most ductile form of the metal, and that this was not confined to the outer layers, but extended to the centre, thus substantiating the theory on which present-day American practice is founded.

Comparisons are made of the physical and mechanical properties of malleable as compared with grey iron and steel castings, drop forgings and compressed steel, and attention is called to the easy machining qualities of malleable iron. Numerous uses of malleable castings are listed, and it is stated that from 200 to 250 lbs. of malleable castings are now used in many of the best types of automobiles for various vital parts.—"Iron Age."

The Joseph Dixon Crucible Company have removed from 28, Victoria Street, S.W., to 22, Duke Street (Stamford Street), S.E.

IRON AND STEEL MARKETS.

Pig-iron.

Only slow, if steady, progress can be noted in the recovery of pig-iron markets, but in trade circles a distinctly more hopeful view of the position is entertained, dependent, it must be said, upon some further levelling down of prices in the near future. It is now clearly recognised that revival of demand for pig for home consumption is likely to be a lengthy process, and until a much more active buying interest can be established, any further expansion of business must necessarily be derived from outside sources. The termination of the American miners' strike will probably check inquiries from that country, while most market reports indicate that business with Continental consumers is now comparatively inactive. In South Staffordshire, while demand for foundry iron remains comparatively idle, it is significant that smelters are now regulating furnace practice to produce a larger yield of forge pig due to an improved tonnage required by finished-iron manufacturers. Scotland, having sold fairly heavily to America, is wanting a little more iron, but Tees-side is not getting as much business as it would in normal times and circumstances. Continental inquiries are all for very small parcels, and very little American business has materialised, although there are still plenty of inquiries. It is now reported that one big firm of producers is fixing a minimum of 90s. per ton for No. 3 Cleveland G.M.B. for export. Other makers have not differentiated as between home and export prices, and to do so is certainly to impose an unnecessary handicap on foreign business. Generally, the price of No. 3 Cleveland G.M.B. may be put at 87s. to 87s. 6d. per ton. The scarcity of No. 1 and silicious iron keeps the price at 95s., but quotations for all the lower qualities are irregular, and business is so very quiet that it is somewhat difficult to fix the figure. No. 4 foundry can, however, be bought at 86s. per ton, No. 4 forge is about 84s., and mottled and white is nominally at 80s., with none offered. Shipments disclose a further decline, the total exports from Middlesbrough during August up to and including the 15th inst. being 12,189 tons, compared with 18,087 tons to July 15.

A sale of 2,000 tons of East Coast hematite for prompt shipment to America is reported at Middlesbrough, but apart from this transactions are all for small quantities, and the demand is so restricted that stocks still tend to increase. Competition for orders is very keen indeed, and prices are again easier. The market price of mixed numbers is now no more than 98s., and even that figure might be shaded, whilst for No. 1 the premium is no more than 6d. per ton if any is asked for at all.

Finished Iron.

The increased demand for forge iron implies some revival of activity in the manufacture of finished material, and this is unquestionably confirmed by the resumption of work at several of the mills and forges in the Black Country, many having been idle for months past. The improvement in the outlook, though exceedingly welcome, leaves much still to be desired. The tonnages shown in the Wages Board returns, however, are much below the pre-war level, and there is still quite a lot of plant irregularly employed, or altogether idle. Demand continues inadequate, and experience does not suggest the nearness of approaching pressure. On the whole, the market may be described as remarkably steady, notwithstanding the slight weakness in the price of merchant and commoner bars. This weakness is not general. There are still firms who hold out for the top price, but, of course, it is all a question of quality, and there is such a wide range that this is not so surprising. Marked bars are steady. Rather better business has been done lately in iron angles, and the reports as to gas strips are more encouraging than they have been for some time.

Steel.

Gradually accumulating strength will perhaps best describe the position of the steel trade at the moment. At present, demand is principally confined to the cheaper qualities of steel material, the higher to the cheaper qualities of steel material, the higher grades being still neglected. The withdrawal of the control over prices of sectional steel is, as yet, too recent to adequately estimate its effect upon trade in general, and the market remains somewhat irregular. The restoration of open competition must, however, eventually react to the advantage of both buyer and seller, and should certainly result in an expansion of business in constructional orders in the immediate future. Semi products are in more active demand, inquiries for billets and sheet bars being in more satisfactory volume than for some time past. At Glasgow, export business in steel is improving much more quickly than the home trade. More inquiries and orders are in the market, and makers are anticipating greater expansion in this branch of the business in the near future. Prices for export show little or no change; in fact, in some cases they are slightly firmer.

Scrap.

With the gradual improvement in trade prospects, movements in the various markets for scrap metals show a somewhat better demand for certain qualities, although buying is still mostly confined to hand-to-mouth quantities. At Middlesborough, the following are nominal prices at the moment :—Heavy steel scrap, 62s. 6d. per ton, delivered works; cast-iron borings and steel turnings, 45s. per ton, delivered, although if any substantial parcels were offered the works would no doubt increase this figure; machinery cast-iron scrap in handy pieces, 70s. to 72s. 6d., delivered; ordinary heavy piling scrap, no demand at all, nominal price 60s. to 62s. 6d. per ton, delivered; special heavy selected forge iron, 70s. to 75s. per ton, delivered, according to specification.

Tinplates.

Influenced probably by holiday causes, business in the tinplate market has to some extent tapered off lately, inquiries on overseas account having been below the average, while Continental demands are also reduced in volume. Markets are, however, fairly well booked up with orders extending into September, but there is needed some assurance of continued production beyond that date. Quotations, as far as basis sizes are concerned for prompt parcels, rule at 19s. 6d. and 19s. 4½d. per box, but 19s. 3d. is freely named for October, with a few buyers at 19s. 1½d. To-day's figures may be quoted for coke tins : IC 14 x 20, 112 sheets, 108 lb., 19s. 3d. to 19s. 6d. per box; IC 28 x 20, 112 sheets, 216 lb., 38s. 6d. to 39s. per box, with lights and crosses at usual differences, net cash, f.o.b. Wales.

Metals.

Copper.—Messrs. Henry Bath & Son, Limited, in their fortnightly metal report under date, August 16, state :—More business has lately been done in refined qualities, the demand for which appears to be improving since the supplies of scrap material have become scarcer. The American quotation for electrolytic has practically shown no change during the whole period under review. It is understood that their surplus stocks of scrap material are also on the point of exhaustion. The Metal Exchange returns of the stocks of copper in warehouse on July 31 show : 1,808 tons refined, 11,509 tons rough, and 183 tons unclassified, together 13,500 tons, against 12,922 tons on June 30. Current quotations :—*Cash* : Wednesday, £64 5s.; Thursday, £64; Friday, £63 17s. 6d.; Monday, £63 15s.; Tuesday, £63 10s. *Three Months* : Wednesday, £64 7s. 6d.; Thursday, £64 2s. 6d.; Friday, £64; Monday, £63 17s. 6d.; Tuesday, £63 12s. 6d.

Tin.—A little recovery followed the recent bad break in this market, carrying prices after the holiday to £161 15s. cash, and £162 three months. This advance, however, induced further realising, and, with buyers holding their hands, prices have slipped back about £3 per ton. The tone at the close, however, was quite good, with America showing a little more disposition to buy. To-day the market has advanced about 35s. per ton. The London Metal Exchange gives the United Kingdom consumption for the first six months of this year as 9,842 tons, against 2,822 tons in the same period of 1921. Sales from the East have been on a much lighter scale and the shipments advised so far are small. Current quotations :—*Cash* : Wednesday, £160 12s. 6d.; Thursday, £161 10s.; Friday, £161 12s. 6d.; Monday, £161 2s. 6d.; Tuesday, £160 5s. *Three Months* : Wednesday, £160 15s.; Thursday, £161 12s. 6d.; Friday, £161 12s. 6d.; Monday, £161 5s.; Tuesday, £160 7s. 6d.

Spelter.—This market during the past fortnight has been somewhat erratic, prices fluctuating a good deal, although within fairly narrow limits. Within the past few days there has been a stronger tone in evidence, with a fair amount of good buying by consumers. The general situation is unchanged, and there is no indication of any material increase in supplies. The Metal Exchange returns show a decrease in stocks of 373 tons, the figures being 4,289 tons on July 31, against 4,662 tons on June 30. Current quotations :—*Ordinary* : Wednesday, £31 10s.; Thursday, £31 12s. 6d.; Friday, £31 10s.; Monday, £31 12s. 6d.; Tuesday, £31 5s.

Lead.—After early steadiness prices began gradually to ease off, especially for near delivery. There had been some heavy arrivals, and owing to interference of the holidays, consumers found themselves temporarily fully supplied. A rather firmer tone was noticeable at the close, with a better demand for forward, and indications that the next move may be in an upward direction. The Metal Exchange statistics show stocks on July 31 as 235 tons, against 268 tons on June 30, a decrease for the month of 33 tons. Current quotations:—*Cash*: *Soft foreign* (prompt), Wednesday, £25, Thursday, £25 2s. 6d.; Friday, £25 5s.; Monday, £25 5s.; Tuesday, £25 2s. 6d.

Company News.

John Hetherington & Sons, Limited.—Profit, £154,617; less depreciation, £7,782; debenture interest, £10,000; debenture trustees' fees, £105; leaving a net profit of £136,729; brought in, £79,613; total, £216,342. Further dividend of 15 per cent. actual on ordinary, less tax, making 20 per cent. for year, and a bonus of 2s. per share, tax free; to general reserve, £100,000; carried forward, £61,573.

William Bayliss, Limited.—The directors of William Bayliss, Limited, report that after making all necessary provisions the profit for the year ended June 30 last amounts to £2,108, which must be written off the adverse balance brought forward from last year. This will leave £1,546 to the debit of profit and loss account. The board have exercised an option to purchase the freehold of the works, and the necessary deposit has been paid. A continuance of trade depression has existed throughout the year, and having regard to these abnormal conditions the directors consider the results achieved satisfactory.

Petters, Limited.—After providing for depreciation and bad and doubtful debts, and after transfer from reserve of £25,000 to meet losses on stocks, the accounts show a balance of £10,917, which the directors recommend be carried forward. Directors regret that position does not warrant payment of any dividend at present. Greatly reduced volume of export trade, combined with reduction in demand for agricultural machinery at home owing to drought of last year, has rendered it impossible to secure sufficient business to cover heavy overhead charges. The long continued dispute in the engineering trade in the early part of this year has also adversely affected operations.

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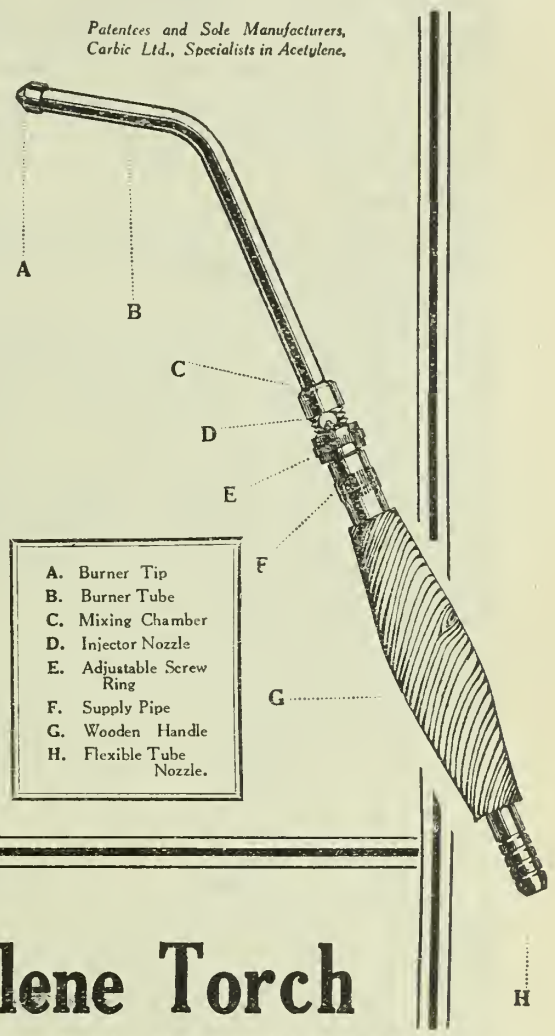

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Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

Bowers & Company, mechanical engineers, have removed from 37, Joseph Street, to 22, Bolton Street, Bradford.

Twelve companies of men resumed work last week at the Hodbarrow Iron Mines, which have been practically closed for the last 15 months.

The small blast furnace at the Level works of the Earl of Dudley, Brierley Hill, Staffs., has been relighted. It was blown out in May, 1921.

The ironstone quarries at Wartnacy, on the county border of Nottingham, reopen on Monday, and the blast furnaces at Alfreton are also being blown in.

Messrs. Joshua Heap & Company, Limited, Ashton-under-Lyne, closed their works on Friday evening, August 18, and will reopen on Tuesday morning, August 29.

F. W. Woodman & Company, 597, Sneinton Hill, Nottingham, are taking over the stock and patterns of the British Engineering & Electrical Company, Leek, Staffs.

The Shipbuilding Employers' Federation has decided to negotiate for a further cut of 10s. in wages for all men employed in shipbuilding, with a view to reducing costs so as to secure more work.

Messrs. Sir W. G. Armstrong, Whitworth & Company have received a contract from the Bengal North-Western Railway for 21 locomotives, which will be built at the Scotswood locomotive works.

Owing to the increased demand for boilers, both for marine and land purposes, Messrs. Yarrow & Company, Limited, have decided to reopen the boiler department at their Glasgow shipbuilding and engineering works.

The Canadian Government Merchant Marine, Limited, is about to start an augmented freight service with the object of encouraging exports of tinplates from South Wales and imports of goods into South Wales from Canada.

An offer made by Messrs. Lithgows, Limited, of Port Glasgow, to lay down four large cargo-carrying steamers speculatively in order to provide employment for men in their district if the men would accept pre-war rates of wages, plus whatever bonuses they might be entitled to, has been unanimously rejected by the Port Glasgow boilermakers.

The Board of Trade has not been convinced that machine-tools imports from countries whose exchanges have collapsed should be charged duties under Part II. (dumping) of the Safeguarding of Industries Act, and it is not at present the intention to appoint a committee under this part of the Act. It is, of course, still open to the applicants to produce further evidence in support of their complaint, but as things stand at present a committee will not be appointed.

Recently the New Zealand Government placed with Messrs. Vickers, Limited, orders for two Pelton turbines and two Francis turbines, each of 3,100 h.p., for the Hora Hora Power Station on the Waikato River. The Pelton machines are now being erected on the site. These machines are designed to operate under a 27-ft. head. This firm recently obtained the orders for the 6,000 k.v.a. generators and the 100,000 volt switchgear for the Mangahao hydro-electric power station in New Zealand.

The Rotherham magistrates last week adjourned the hearing of six summonses against Sidney Herbert Aizlewood and Frank Else, partners in Aizlewood and Taylor, iron and steel scrap merchants, instituted by the Inland Revenue Department. Prosecuting counsel stated that the firm's accounts had been falsified for nine years, and that the total income-tax, E.P.D. and super-tax missed owing to the action of Taylor, who is now dead, Aizlewood and Else was £18,494. Else is a member of the Sheffield City Council.

The Executive Council of the Amalgamated Engineering Union have had under consideration the position of the organisation, due to events which accompanied the recent lock-out, and especially the causes which have led to a serious reduction in the membership. It has been decided to invite suggestions from the rank and file with regard to reconstruction, and an endeavour is to be made to get all craftsmen into the society. Owing to the prospective reduction in the wages of engineers, the executive council have decided to restore contributions to normal rates.

In accordance with the agreement of the Welsh Engineers' and Founders' Conciliation Board, made on May 10 of this year, which governs the wage rates of craftsmen both at Siemens steel works and tinplate works, wages as from August 6 are again reduced by 2s. per week. Smiths' and fitters' wages are now £3 13s. 6d per week. The wage rate at the beginning of May was £4 0s. 6d., and this was reduced by 2s. 6d. per week on May 14, 2s. 6d. on June 11, 2s 6d. on July 9, and 2s. on August 6, making a total reduction since the beginning of May of 9s. 6d. The present wages are to continue until December 31, but a meeting is to be held in November to review the position for January, 1923.

An agreement has been reached between the federated steel makers of Sheffield, the District Rolling Proprietors' Association and the Sheffield Forgers and Tilters' on the one part, and seven trade unions on the other part, for reductions of war bonus received by men employed in the heavy steel departments of Sheffield and the rolling mills, forges, and press shops. The effect of the agreement is that the war bonus in rolling mills and forges will be reduced by 2s. 6d. per shift from September 25 next, this cut to be made in three instalments, 10d. on August 14, 10d. on August 28, and 10d. on September 25. The reduction for 47-hour week men employed by members of the Rolling Mills Proprietors' Association and the Sheffield Forgers and Tilters is 16s. 6d., to be made in three cuts of 5s. 6d. on the three dates mentioned. An agreement on similar lines has also been entered into between the federated steel makers and the Iron and Steel Trades Confederation with regard to Siemens melting department, electric furnace, and crucible steel melting departments.

Some very interesting figures showing the rise and fall in the wages paid by Hadfields, Limited, with the contemporaneous rise and fall in the cost of living, are given in an article contributed by Sir Robert Hadfield to the August number of "Current Opinion," the official organ of the Industrial League and Council. "It was thought at one time," says Sir Robert, "that rapid rates of increase in wages would greatly benefit the worker, but alas! he found that as fast as his wages advanced, so did the cost of living and commodities. I recently had prepared a diagram of my firm's case. During the war we represented a total complement of some 15,000 workers. We have now about half this. I have had this carefully worked out, and find the worker in the years 1915 to 1921 has really lost 18 per cent. as compared with the old rate of wages, the cost of commodities remaining as before. In saying this I do not mean he is in any way to blame for the turmoil which has occurred. Quite the contrary. But in his eager attempt to secure his position, as he has thought, he has only helped to make matters worse, and is not so well off. The above figures are taken from definite data carefully kept by my firm."

Deaths.

Dr. Gisbert Kapp, the well-known electrical engineer, has died at his residence at Birmingham. Deceased was formerly professor of electrical engineering in the Birmingham University.

Colonel R. Saxton White, who has recently passed away at his residence at Bournemouth, was manager of the Walker Shipyard of Sir W. G. Armstrong, Whitworth & Company from February, 1883, to December, 1888, when he left to take up the managing directorship of the shipbuilding department of the Fairfield Shipbuilding & Engineering Company, Glasgow, which post he resigned about 1895, and returned to the Walker Shipyard as assistant to the late Colonel Henry Frederick Swan, in February, 1896, where he remained until December 22, 1920, when he retired.

Personal.

The late Dr. John Theodore Merz, Ph.D., LL.D., D.C.L., of Newcastle-on-Tyne, left £18,980.

The late Right Hon. Thomas Burt, P.C., D.C.L., of Burdon Terrace, Newcastle-on-Tyne, left £5,123.

The late Mr. William Blow Collis, J.P., of Swinford House, Stourbridge, consulting engineer, left £20,517.

The late Mr. John Thomas Middleham, secretary and director of Hadfields, Limited, Sheffield, left £28,380.

Mr. S. Williamson, the late general manager and secretary of the Cambrian Railways Company, has joined the directorate of the Welsh Town Planning and Housing Trust, and has been appointed deputy chairman.

Mr. Robert Hobson, President of the Steel Company of Canada, Limited, of Hamilton, Ontario, is at present on a visit to England, and is expected to return home early in September. (The London office of the company is at 88, Leadenhall Street, E.C.3.)

China's Output of Iron Ore and Pig-iron.—China's annual production of iron ore is estimated at 2,000,000 tons. Her annual pig-iron output is about 450,000 tons from Chinese-owned and operated furnaces and 250,000 tons from Japanese-owned furnaces.

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Contents.

	PAGE
Russian Metallurgy and Semi-Steel	173
Foundry Queries	174
French Foundrymen's Autumn Conference	174
A Modern Installation of Drying Ovens	175
Blast Volume	177
A Quick Breakdown Repair Job	177
Costing for a Small Foundry	178
An Apprenticeship Course in Foundry Practice—VII.	179
Contracts Open	182
A New Puddling Process	182
Small Runners and Sound Castings	183
Plaster Patterns	184
Eliminating the Gas Regenerator Chambers in the Open-Hearth Process	187
The Institute of Metals	187
Trade Talk	188
Company News	188
Iron and Steel Markets	189
Personal	190
Deaths	190

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Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Russian Metallurgy and Semi-Steel.

Technical and scientific work has been pursued in Russia throughout the Revolution, but the results obtained are slow in arriving in Western Europe. M. Léon Dlougatch, however, has given an account in the July number of *Revue de Metallurgie* of the first congress of Russian metallurgists held since the beginning of the war. It took place at Moscow in November, 1920, when 220 professors, engineers and metallurgists had presented to them 69 papers, of which no less than 66 were of a scientific character.

In order to visualise the situation, the Chairman, Mons. S. N. Vankoff, gave statistics showing the relative metallurgical productions of the various manufacturing countries, and especially dealt with the United States, and in conclusion, stated that the natural resources of Russia were not less important than the States, and were certainly superior to any European country. Russia possessed everything necessary to develop its metallurgical industries, quite independently of other countries. The failure at the moment was due to lack of education and organisation. The war and the revolution had reduced all metallurgical operation practically to vanishing point.

Naturally the first subjects to be studied were the winning of raw materials and their transport, taking into the consideration the state of the country and its means of communication.

The programme was divided into two sections, theoretical and practical. The former admitted of seven subsections, having the following captions:—(1) Metallurgical raw materials, (2) special regional problems, (3) railways and transport in relation to metallurgical industries, (4) economical aspects with special reference to the standardisation of both raw and manufactured metallurgical material, (5) metallurgical resources of Russia, (6) the relation of metallurgy to modern industry, (7) technical societies.

The practical session was devoted to such subjects as the lack of raw materials and the steps to be taken to overcome it; the re-birth of Russian metallurgical industries; essential means of communication to effect this; mines and geology from the metallurgical aspect; technical schools to be placed on a new base to meet the current needs of the country. These questions were thoroughly discussed, and it was decided that peat-coke must be extensively used both in blast furnace and cupola practice, as the Donetz coalfield could not be relied upon to produce coke for a considerable period. The five following resolutions were passed:—(1) The maximum amount of turnings, as they rapidly deteriorate *must* be used wherever possible. (2) Trials must be made for using turnings in the coke-fired blast-furnaces, as they have already been a success in the charcoal-fired ones. (3) A works at Moscow must be specially laid out for the baling of turnings, in order that they can be used in Siemens' furnaces. (4) New steel and cast-iron turnings must preferably be used in cupolas, and their needs satisfied, then open-hearth furnaces and blast-furnaces. (5) Briquetting works must be installed in the various metallurgical centres, in order that turnings may be most economically worked up.

Aluminium and nickel were considered to be of such importance that the Congress decided that not only surveys should be undertaken, but a nickel smelting works should be put down in the Urals.

After setting out definitely the most urgent lines of communication to be constructed, the Congress then laid down the basic principles to be followed in the building up of their metallurgical industries, and amongst these are found the following:—(1) The utilisation of very rich iron ores in order to reduce to a minimum the amount of fuel necessary. (2) The use of turnings and mill scale wherever possible. (3) The reduction to a minimum of the pig-iron used in the open-hearth furnaces. (4) The extensive utilisation of peat in gas producers. (5) The use of powdered fuel. (6) Semi-steel to be used as much as possible, as this introduces a dual economy by reducing the consumption of both steel and foundry pig-iron.

Semi-steel has evidently been studied considerably in Russia, especially by Professors Botchvar and Kaliumkoff. According to these workers, the best type of semi-steel is that possessing a structure consisting only of graphite and pearlite. The heating of semi-steel to within the range of 100 to 600 degs. C., followed by slow cooling, is practically without effect on either its texture or mechanical properties. Heated, however, to 800 deg. C., and rapidly cooled, semi-steel takes the quench, and shows a texture consisting of martinsite and graphite. Additionally its Brinell hardness is doubled. Semi-steel is easiest to treat thermally when its composition approximates the following:—Total carbon 3.0 per cent; graphite carbino.

2.2 per cent.; manganese, 0.85 per cent.; silicon, 1.1 per cent., whilst the sum of the Si. and Mn. here is given as 1.95, it can be as low as 1.75 per cent. As stated the texture must be pearlite and graphite only. Tempering between the temperatures of 100 and 400 deg. C. can vary the properties of semi-steel considerably, but from 500 to 600 deg. C. greater improvements are shown. Transverse strength is increased some 21 per cent., Brinell ball hardness decreased by some 50 per cent. when compared with quenched semi-steel, and increased 10 per cent. in comparison with the untreated material. Resistance to shock is increased from 10 to 12 per cent. It is preferable to quench semi-steel in oil, though water can be used. The authors point out that by controlling the constitution of semi-steel and its thermal treatment, it is possible to obtain castings of an exceptional quality.

Foundry Queries.

A Lead Casting Proposition.

Could you give me any information how to get a good lead or soft metal casting run on to a plaster cast. I have tried several methods but without success. I want a plaster of Paris cast for moulding a ten-inch disc, $\frac{5}{8}$ in. thick, with a few recessed places and the rest requires to be perfectly level, with a good face. I should be very glad if you could give me any suggestion, as I cannot get the metal to lie on the plaster cast; it boils until set and leaves great holes on the face.

"R. U."

The trouble of making plaster of Paris moulds is that they must be perfectly free from moisture before they can be used for casting lead or any other metal on to them. Since aluminium, brass, bronze and iron, and even silver can be successfully cast in plaster of Paris moulds, there should be no trouble experienced with the lower melting point metal like lead or some of its alloys with tin or antimony. If a pattern metal is wanted which will expand slightly in the mould, then 75 per cent. of lead, with 17 per cent. antimony and 8 per cent. of bismuth will be found useful, cheaper mixtures can be used without the bismuth. In every case, however, the drying of the mould must be perfect, otherwise steam will be given off and the casting will be full of blow holes.

In the first place when making the cast, the plaster of Paris is best mixed with warm water at about 170 deg. Fahr. (75 deg. C.), and as it would be too dense, and not porous enough if used alone, it is advisable to mix it while still dry with about an equal quantity of fine red-brick dust. To prevent the cast from sticking to the pattern or from adhering at the parting, oil or vaseline should be used to effect the separation.

When the plaster is thoroughly set, the drying operation may begin and this takes considerable time, as it must first be dried at a low temperature, such as a warm atmosphere, but not in a hot oven. The last traces of moisture are only removed by heating the mould to redness, preferably in a muffle, until the cast is equally hot throughout. As the mould will be soft and friable after this treatment, it is advisable to strengthen it with wires or nails similarly to an intricate core.

Before casting the lead into the mould, the latter should be embedded in sand to hold it together. It is sometimes claimed that by using some oily substance, such as lard, with which to soak the mould, that any slight amount of moisture left in the plaster will be prevented from blowing, but it is generally of the greatest importance to ensure that all the moisture is expelled from the plaster, as otherwise the hot metal will either scatter, or refuse to lie on the plaster surface and cause the holes which have evidently been the cause of the trouble.

T. J. P.

Aluminium Castings.

We have lately been casting some aluminium, the patterns are perfect, but the castings do not come out as clean as we would like. We should be very glad if you could give us any information on this subject, or do you issue a text book on aluminium castings?

Argil.

Very seldom is pure aluminium made into successful castings, and it is generally some alloy of this metal with either copper or zinc which is used commercially, and these alloys should always be referred to by their composition and not by a "number" which may lead to confusion.

In the first place the melting of the alloy should be carefully conducted as unsoundness frequently arises from too prolonged a time in the furnace irrespective of temperature, and too high a temperature even for a short time is equally harmful. Too high a temperature of pouring is perhaps the most fruitful source of defective castings, whether from the view point of pin-holes, or defective surface. For anything but the very smallest castings, the metal should be poured at the lowest possible temperature consistent with free running, say about 1,250 deg. Fahr. (625 deg. C.), and if the crucible is withdrawn from the furnace at a higher temperature as judged by a pyrometer, then the metal should be allowed to stand until it has reached this before attempting to cast.

The next most important consideration is the type of sand used, which must not be too fine, as this would prevent it from being free venting, nor too coarse, which produces a bad effect on the surface finish of the castings. A good sand suitable for high-class brass or bronze work should be quite suitable for aluminium alloys, and no attempt should be made to use artificial facing, as it usually acts as a trouble producer.

New sand with just sufficient clay naturally present to give it a satisfactory bond is the best for facing the mould, and if this sand shows any tendency to adhere to the pattern or at the parting, then both these can be lightly dusted with fine talc or French chalk. Facings with any organic matter in them are specially harmful, as this, by burning in contact with the molten metal, causes the latter to boil or bubble and make holes.

Too hard ramming of the sand close to the pattern can also prevent the metal from lying on the tight spot, and of course the mould should be thoroughly cleaned of any loose particles before it is closed, as aluminium or its alloys are so light that they can enclose loose sand particles just as easily as float them up the riser.

We do not know of any satisfactory text book on the subject of aluminium casting, but the United States Bureau of Mines has issued very valuable instructions to aluminium founders from the research work done for them by Mr. R. J. Anderson, whose papers have been published in this country, and the recent meeting of the American Foundrymen's Association devoted a whole session to the discussion of aluminium foundry problems which are now being reported in the technical journals here.

T. J. P.

French Foundrymen's Autumn Conference.

The Annual Conference this year is to be held at Nancy, on October 5, 6 and 7. The following Papers will be read and discussed:—

(1) A Further Study of the Metallurgy of Malleable Cast-Iron, by Marcel Remy (being a continuation of the Paper he submitted to the Liège Conference in 1921).

(2) Some Factors influencing the Quality and Strength of Cast-Iron during Melting in the Cupola, by Christian Kluytmans.

(3) (*a*) Note on the Inspection of Foundry Pig-Iron; (*b*) A Thermal Study of Cupola Practice, by Mons Seigle.

(4) The Influence of Phosphorus on Brass, by A. Portevin.

(5) A Practical Study of the Working of Side-blown Convertors, by Mons. Levoz.

(6) The Electric-Furnace in the Brass Foundry, by Mons. Brasseur.

(7) "Alpax"—a new light high-tension Alloy, and its Uses, by Mons. de Fleury.

Other Papers will be given by the Belgian and American foundrymen's associations. Amongst the works to be visited in the Nancy district is the foundry of the Etablissements Delattre and Frouard at Frouard.

Additional information can be obtained by applying to Mons. J. Carles, Association Technique de Fonderie, 10 rue de Lancry, Paris, x.

A Modern Installation of Drying Ovens.

The drying stove or oven is one of the important auxiliaries of foundry equipment which until comparatively recently has certainly not received the investigation and attention which it deserves. This is no doubt due, in the main, to the fact that it has been the exception rather than the rule to keep separate records of fuel costs for the stoves, and if the performance of the ovens was reasonably satisfactory in tonnage output, their working costs did not come into question.

The more exacting requirements in engineering practice of to-day, however, demand a very much higher efficiency in drying, if castings losses are to be kept within commercial limits, and in his search for an oven which will give him a uniformity of production, the foundry manager has not unnaturally given due consideration to the costs attendant upon the attainment of such uniformity.

Some twenty years ago Mr. H. M. Lane, the well-known American expert on foundry practice, was called upon in his capacity of consulting foundry and metallurgical engineer to solve a good many foundry problems, troubles which the foundrymen were blaming on to the metal, but

Fig. 1.—Battery of Four Mould Ovens.

which in a number of cases were conclusively proved to be due either to the moulding sand or the cores, and with the advent of the automobile cylinder with its extensive thin water-jacket cores it became necessary to make a core of maximum strength and minimum gas content. The castings loss with the old-style ovens rose to alarming proportions, and many experiments were made with a view to evolve a design of oven which could produce a uniform drying heat and turn out more satisfactory cores. Gas-fired, oil-fired, solid-fuel-fired, and even electrically-heated ovens were experimented with. The oil binder was, of course, the best for certain classes of cores, and where such a binder was employed it was not merely a straight drying problem but a chemical reaction which was involved, and it was necessary to sweep a large volume of air through the oven and oxidise the oil. Forced-draft ovens were tried, but the forced draft increased the temperature of the incoming gases, and resulted in irregular temperatures in different parts of the oven, burning a good many of the cores. It was then that Mr. Lane took out his first patent, which provided for the introduction of auxiliary air into the products of combustion after they had been formed, so as to dilute such products, reduce their temperature, and furnish a larger volume at a lower temperature which could be safely applied to the drying of cores. Under this patent many ovens were built involving all classes of fuel.

An oven with a large number of holes in the walls for the introduction of pyrometer thermo-couples was fitted and another set of tests run. It had been found in practice that a little back of the centre of the oven, on the floor, was a point where the cores did not dry properly. In the old-style oven it had been proved that at least 80 per cent. of the gases in the oven were re-circulated. With the forced-draft oven this had been greatly reduced, and the moisture eliminated more quickly, but with the solid-fuel-type oven and the outlets near to or flush with the floor, there was always a blanket of moist or relatively cold air near the floor which carried a large percentage of moisture, and did not permit the rapid drying of the cores in this part of the oven. To get the moisture out of the oven without re-circulating, and to effect drying clear to the bottom, Mr. Lane constructed a hollow chamber beneath the floor, into which the products of combustion or moisture could descend and from which they could be exhausted. This arrangement, which is covered by patent rights, had a revolutionary effect on the performance of the oven and resulted in castings loss being reduced to a minimum.

As the outcome of the experience gained in his lengthy experiment, Mr. Lane decided there were three cardinal points essential to the efficient and economical working of a drying oven:—(1) Introducing into the oven a large volume of gases at a relatively low temperature when compared with the temperature of combustion in a forced-draft firebox. (2) The sweeping of these products of combustion through and around the cores or moulds in such a way as to effect a heat exchange between the incoming products of combustion and the material in the oven. This heat exchange naturally results in the extraction of moisture, and such extraction rapidly cools the gases, carrying them with the moisture content to the bottom. (3) To trap the moist air in such a way that it cannot re-circulate, and to get it out of the oven as quickly as possible.

The Lane patent forced-draft auxiliary-air core oven has been designed to meet the above-mentioned requirements, and on a recent visit to a large foundry in Sheffield our representative had an opportunity of seeing an installation of ovens built and erected by Messrs. August's Muffle Furnaces, Ltd., Halifax, who have acquired the sole selling and manufacturing rights of "Lane's Patent System" in Great Britain. The installation under notice consists of a battery of four mould ovens each 12 ft. × 24 ft. × 10 ft. The method of travelling the carriage in and out of the stoves is novel and simple. The carriage consists merely of a substantial girder frame, the bottom members of which are placed longitudinally in tandem with the oven floor; two parallel grooves are provided in the oven floor and are extended

for a distance into the shop; these grooves are charged with cast-iron balls, and it is upon these balls the carriage is travelled by means of a jib. The stoves are placed two on either side of the firebox, which is situated in a special pit below ground level. Air is supplied at about 3-in. w.g. by a small fan driven by a 6-h.p. motor; no additional pull is obtained from the steel chimneys, which are merely sufficient to take the spent gases clear of the building. A full charge for one of the ovens is 90 boxes, the total weight of the charge, including boxes, being approximately 40 tons. The time for drying is about eight hours, with a temperature of 250/280 deg. C.

It is not possible to give fuel consumptions which are fair to the ovens, as they have not yet been worked to their full capacity. Starting from cold, however, on three ovens charged with 120 tons of metal and sand at 4 o'clock P.M., and drawing the ovens at 7 o'clock A.M. next day, the total consumption of best coke was 30 cwts., though obviously the second charge would have been got out with not much more than half that consumption. Best coke only is used, as experience has shown this to be most economical.

The core shop is provided with a battery of seven ovens of the chamber type and one of the drawer type. Of the first-named two are 6 ft. × 8 ft. deep × 6 ft. 6 in. high, and five 6 ft. × 4 ft. deep × 6 ft. 6 in. high. All these ovens are heated from a central firebox with blast supplied by a fan similar to that of the mould ovens.

In connection with the core ovens Messrs. August's muffle furnaces are responsible for two useful innovations, one being the portable rack which is run along a line of track from the core bench to the oven. In the foundry seen by our representative a large number of these racks are in use as storage racks; this affords a very convenient method of carrying the cores, and at the same time reduces the necessity of handling. The second innovation is the mechanical contrivance for withdrawing and supporting the drawers of the drawer-type oven.

The arrangement and system of heating may be briefly described as follows:—The air from the fan is driven into the pit and warmed, just sufficient air being allowed to pass through the bed of the fire to maintain a red glow—a temperature far below that of producer gas. By a series of flues, large quantities of air are heated, further air being allowed to pass over the fuel. A special chamber provides for the auxiliary air and also serves as a mixing chamber for the air and gas. The heated air and products of combustion from the firebox are drawn into a large flue which acts as a reservoir from which heat can be tapped as and when or where required.

Regulating dampers are fixed at the back end of the chambers from which the heat travels in the direction of the chamber doors. At the front of each chamber perforated plates and dampers are attached to a series of flues, the arrangement of which provides such control over the heated air that an absolute uniformity of temperature is obtained throughout the whole of the drying chamber. The air ultimately passes into a common outlet flue and thence to the stack, which, as already stated, serves no other purpose than to conduct off the fumes.

We may now consider some of the particular and peculiar features of the system. It will at once be evident there is complete control over the rate of combustion, the independence of the chambers to each other tending to reduce fuel consumption to a minimum. The independent arrangement of the chambers also permits of a battery of ovens being worked at varying temperatures by a simple regulation of the dampers.

The advantage to be derived by extracting moisture from a core or mould with uniformity, and equal application of heat for baking, will be too generally appreciated to need comment. If heat alone were the drying medium, it would be impossible to get the whole of the moisture away from the core or mould without condensation taking place in the chambers, and it would also be practically impossible to dry a core or mould absolutely uniformly. In whatever direction the heat was travelling the surfaces of the sand structure facing in that direction would be dried first. In the drying of oil sand cores a liberal supply of oxygen is essential, a condition which is fully satisfied in the system under notice.

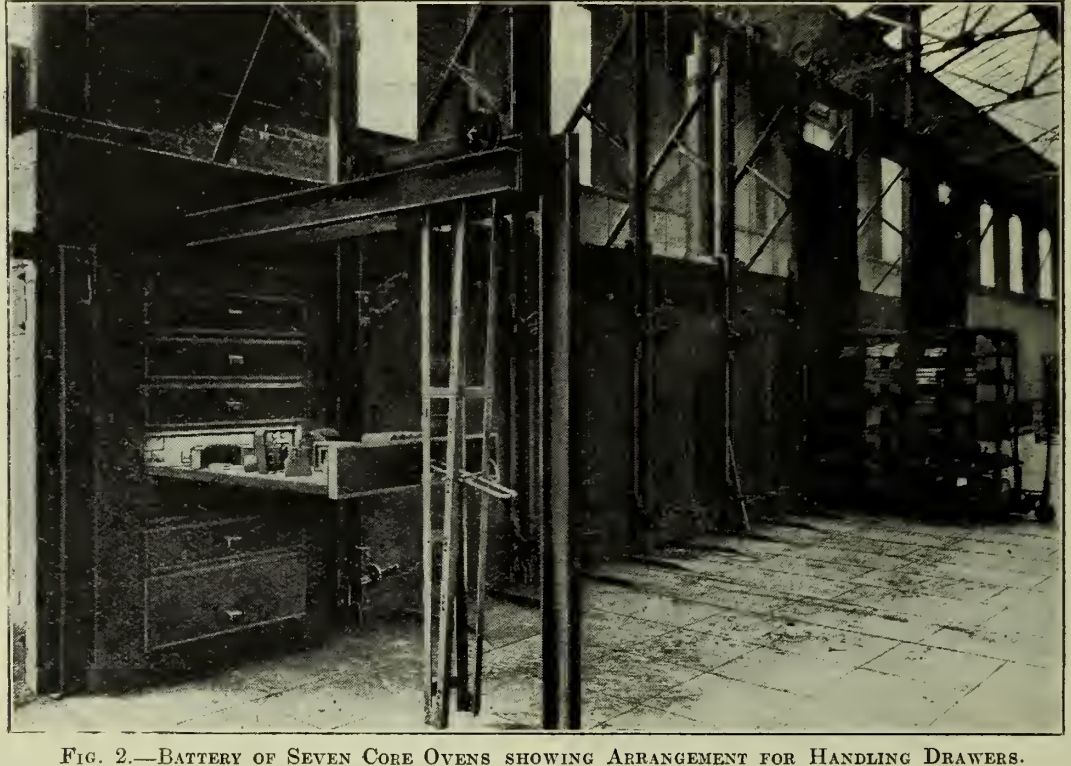


Fig. 2.—Battery of Seven Core Ovens showing Arrangement for Handling Drawers.

German Railway Rates.—As a result of the depreciation of the mark, the German Railway Administration has decided to increase the present goods tariff by 50 per cent. as from September 1, but the more recent slump may entail a greater increase.

Sociedad Anónima Franco Belga de las Minas de Somorrostro.—This concern reports for 1921 that the coal strike in Great Britain greatly affected the Company's business. Their sole customer while the crisis in the British pig-iron industry lasted was the Sociedad de Altos Hornos de Bilbao. The sales in 1921 were:—First quality ore, 58,262 tons; washed ore, 20,260 tons; roasted ore, 28,880 tons; total sales, 107,402 tons. The amount available for distribution is 413,768 fcs., which allows for the payment of a dividend at the rate of 7 per cent. (35 fcs. per share).

Blast Volume.

By P. A. Russell, B.Sc.

The importance of the volume of air that is delivered into the cupola is repeatedly being emphasised by all experts on cupola practice, but the difficulty that confronts most ordinary foundrymen is the installation of some instrument with which to measure this volume. There are several good instruments on the market, but their cost prohibits them in the smallest foundries.

This problem becomes much more important where the blast is supplied by a fan. A positive blower will, within limits, deliver a constant amount of air when driven at a constant speed, but the air delivered by a fan varies greatly according to the resistance which the stream of air meets with upon its course. This difference is very great in irregular cupola working, and practically the only means of detecting it is by means of some instrument to measure the quantity of air delivered.

The simplest form of volume meter consists of the Pitot tube, by which the speed of the air in the blast main is measured in ft. per second, which, when multiplied by the area of the main, gives the volume supplied in cubic ft. per second.

The author has installed a home-made apparatus of this type, from which he has been able to obtain some very useful information about the working of the cupola to which it is attached.

The materials required were 3 ft. of brass tubing, a few feet of rubber tubing, and 2 ft. of glass tubing, add 5/32 in. internal dia. A sketch of the apparatus is shown in Fig. I.

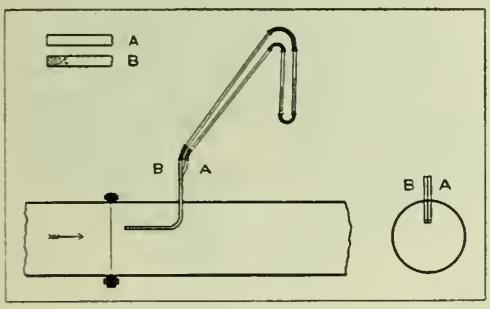


Fig. 1.—A Home-made Blast-Volume Meter.

The tubing was sawn into two lengths of 18 in., and one end of one piece stopped with a brass plug, and 8 small ⅛-in. holes drilled into the side of the tube just below the plug. Each tube was then bent through a right-angle at the centre, and the two soldered together side by side. These were then introduced and soldered into the blast pipe, so that the ends of the tube were one-third of the way into the pipe, and the tubes pointing square along the pipe. One-third across the pipe is taken as the position of average velocity of the stream of air. Two 1-ft. lengths of glass tubing were jointed together with a short length of rubber tubing, half filled with water, and fastened into a board in a convenient position for reading the level of the water. The open ends of the tubes were connected to the open ends of the brass tubes by rubber tubing.

How it Works.

The effect, when air is passing along the blast main, is this:—The pressure of air that tries to escape through the tube B is solely due to the pressure of the air in the main, but in the tube A this is supplemented by an amount due to the speed of the air travelling along the main, and attempting to pass up the tube. Thus, as the two tubes are connected one to each side of the water gauge, the pressure on the side of the tube A will be equal to the pressure in the main plus the pressure due to the velocity of the air and on the side of B, the pressure in the main alone. Thus, the water in the gauge will show the pressure due to the velocity only. Therefore, by reading the height of the water in the tubes it is possible to obtain a measure of the velocity at which the air is being delivered into the cupola, and consequently the quantity of air delivered per minute.

For observations on the comparative working of a cupola under different conditions the measurement of this difference in level is sufficient. Thus, if the fan can be run at various speeds, a series of observations can be made to determine what blast velocity (or quantity) gives the best results.

Results Obtained.

It was found that, with a fan running at constant speed, the delivery of air varied considerably throughout the blow. Several factors enter into this, the main ones being the amount of charge in the furnace, the size of coke, etc., and the state of the tuyeres. It was most noticeable when the tuyeres became partially blocked by chilled slag forming in front of them, that the delivery of air fell greatly, and a careful use of the bar rectified this at once. The effect of the hanging of the furnace was also noticeable on the water gauge. Thus, by a little observation, any irregularity in the working of the furnace can be easily detected.

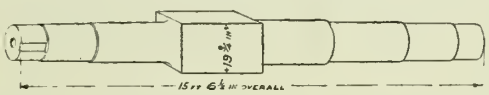
An ordinary pressure gauge gives practically no indication of any of these irregularities, only showing a slight drop in pressure as the furnace is blowing down, whereas at the same time the Pitot tube indicates a great increase in the quantity of air delivered.

But if it is desired to obtain absolute figures of the quantity of air delivered, the problem becomes more complex. The formula usually given for the Pitot tube is:—Velocity in ft. per sec. = 58.9 × head of water in inches, but the author has, so far, been unable to check whether this is true for the particular type described, though it appears to apply, or very nearly so. Also corrections, though slight, need to be made for the temperature of the air.

This, however, is not necessary for ordinary routine work, and if the height of water which corresponds to the best working of the furnace is determined, and steps are taken to see that this is maintained throughout the blow, a great increase in the economy of the furnace and regularity of the product can be obtained.

A Quick Breakdown Repair Job.

A smart bit of engineering repair work has just been carried out by Messrs. Walter Somers, Ltd., of Halesowen, in connection with a breakdown at the Newport Works of Messrs. John Lysaght, Ltd. A new forged steel shaft was required, and the order for it was received by Messrs. Somers on the afternoon of Wednesday, August 2. The shaft, which we illustrate herewith, required to be forged, heat-treated, finish-turned to gauges on diameters, the square middle portion to be planed to gauge, keyways cut in each end, and a



4-in. hole bored through the entire length of the shaft. As it was a breakdown job, Messrs. Lysaght gave instructions for the work to be carried on continuously until the shaft was completed. By so doing, Messrs. Walter Somers, Ltd., were able to get the shaft finished and loaded on to a truck by mid-day on Tuesday, Aug. 8, and despatch it to Newport. The Great Western Railway arranged for the shaft to be delivered next day at Newport, and Messrs. Lysaght immediately got to work, and keyed on a large gear wheel to the central portion, fitted two eccentrics, put on the crank webs at either end, and were able to get the mill running again on Monday, August 14.

Sociedad Minera y Metalúrgica de Peñarroya.—This Franco-Spanish concern is distributing for 1921 a dividend at the rate of 9 per cent., as against 17 per cent. in 1920. The report states that the situation at the collieries has not improved. The competition of British coals has been very great, especially during the second half of 1921, and the import tax of 3.50 to 7.50 fcs. was not sufficient to keep the foreign coal out of the country, especially in the coastal regions and their immediate neighbourhood. The Company's coal output has fallen off from 563,191 tons in 1920 to 513,271 in 1921.

Costing for a Small Foundry.

By F. A.

The object of this article is to describe the methods adopted by the writer to obtain fairly accurate costs for the castings produced in his foundry. The total probable requirements were not expected to exceed 7,000 lbs., made up of the following details:—

Material.	No. of Castings.	Weight in lbs.
Iron	272 ...	3,025
Aluminium	960 ...	3,285
Phosphor bronze	288 ...	537
Brass	160 ...	48
	1,680 ...	6,895

Actually, the requirements never exceeded two-thirds of the above. The total floor space available was approximately 3,000 sq. ft., which included cupola stage, this being on same level as the upper portion of building, where non-ferrous castings were produced.

Owing to constant changes in design, it was not advisable to mount patterns on plates, the method adopted, chiefly with the smaller castings, being to work from plaster match plates, as being easily replaced at small expense on the frequent occasions when change in design rendered them obsolete. The heaviest castings were, roughly:—Iron 70, aluminium 45, bronze 5 lbs., and brass 6 ozs.

The only labour available was local, and in no single instance had there been any previous foundry experience. Considering that practically all the castings required a fair amount of machining, being for motor-car manufacture, it will be agreed that the task was no light one. However, with the exception of the cylinders (four-bore type), excellent results were obtained, the difficulty with these being due to the irregularity of the quality of the cores, which made it necessary to allow a large margin to ensure that the machine shop was not disappointed. Seeing that the cores, including the oilsand jackets of a rather delicate type, were made by girls with no previous experience, this was only to be expected. The average output of these cylinders was about 12 sound castings weekly.

The total number of employees was 20, which were allocated as follows:—Moulding 7, coremaking 6, iron and non-ferrous melting 1 each, labourers 2, dressers 3.

The only machinery was a direct motor-driven fan, a sand mill, and a pair of 15 in. × 2 in. grinding wheels, driven by another motor. All gates and runners were removed by hack-saw or hammer and chisel.

The numbers on the patterns were rather involved, and to avoid turning each workman into a clerk, each was known by a foundry job number, and in the case where several patterns of a different number were mounted on the one plate, a foundry job number was given to the whole box of patterns, which might contain 3 to 10 castings per box.

In this way job numbers 1 to 9, inclusive, related to iron; 10 to 26 to aluminium, and 37 to 40 to bronze and brass.

Each employee had a job card, on which, in space provided and according to the code below, he indicated the job on which he was engaged. Thus, A signified moulding, B core-making, C dressing castings, D melting, and E labouring.

Moulders required a separate card, which lasted the whole of the week, for each job number. In the case of coremakers and dressers, only the more important jobs were booked direct to the jobs on separate card, the others being grouped under a general heading, as B iron; or C aluminium, meaning respectively coremaking for iron castings, and dressing aluminium castings. The furnacemen would put D iron or D brass and aluminium, indicating that the time was due to melting iron and melting non-ferrous metals respectively.

Labouring by any person would be described as E iron, E aluminium, E bronze, according to section engaged upon.

In ascertaining the cost of any particular casting or group of castings, the form set out is used, the cost of the metal being brought down to a price per lb., which includes coke, furnace repair and materials; while the furnaceman's, labouring and casting wages are placed in their respective columns, D and E, at their price per pound.

Moulding, as previously stated, is always a direct charge, and placed under A. Coremaking may be either direct or indirect. If the latter, it is charged at a rate per pound under B. Dressing is treated similarly to coremaking, and placed under C. In calculating these indirect charges for the price per pound factor, the gross weight of all *indirect* product only is placed against the *indirect* labour cost.

The whole of the information regarding labour L and metal M being now obtained, the cost can be worked out from the formula:—
M + L + (% of L for S.E.) + I = gross cost, G.C., I being a percentage of L + S.E. as insurance premium against wasters.

In the example given, the casting is a cylinder, and I has been taken at 20 per cent. S.E. was taken at 100 per cent. of L, and included interest on capital outlay on plant and buildings, insurance, rent, rates and taxes, salaries, stores, repairs, power, haulage, small office expenses, and general stores.

Profit is generally reckoned as the difference between market prices and own costs when the foundry is supplying their own machine shop direct.

To verify any system of cost-keeping and prove its correctness, the value of the product should be taken over a period of one week, or longer, and compared with the total expenses incurred over the same period. They need not necessarily balance, as, if the insurance factor, I, has been used liberally and the foundry has been having a run of luck, there may be a balance to the good.

The satisfaction in knowing that one is making a profit is worth the time taken in getting out the necessary particulars.

Taken at a price per lb., the individual jobs or groups of jobs in some cases were abnormally low, and in other cases high, depending on proportion of labour and risk as compared with the weight. This shows the folly of some firms' methods in charging a uniform price per pound. Actually, the analysis of the costs showed that, with 17 castings comprising one set of iron castings, there were eight widely different prices per lb. The lowest was for fly-wheels, and the highest for exhaust pipes. Cylinders occupied an intermediate position. There was no hoist, with the exception of a small box hoist used solely for delivering the cores for the cylinders and other iron jobs from the coreshop on the first floor, so that the whole of the materials for the iron furnace, milled sand and materials for non-ferrous castings, and core materials for the coreshop had to be brought upstairs by hand.

The writer is certainly not recommending the establishment of any foundry using such obsolete methods, but the results obtained show what can be achieved by proper organisation, even with such limited means at one's disposal.

Form I showing a system of costing applicable for small old-fashioned foundries.

Prt No.	Job No.	Weight.	A.	B.	C.	D.	E.	Total L.	% L = S.E.	Allowance for Scrap.	G.C.	Cost per lb.
A 2—1	1	69 lbs. @ 1½d. 8/7½	5/6	4/-	2/-	69 lbs. @ ·3d. 1/8¾	69 lbs. @ ·3d. 1/8¾	14/11½	100 % of L =14/11½	20 % of L + S.E. 6/-	44/5½	7.73d.

An Apprenticeship Course in Foundry Practice.—VII.

By Ben Shaw and James Edgar.

MOULDING BOXES AND SECTIONS.

When it is recognised that moulds, apart from those which are made in open sand or loam, must be made in sections to obtain correct impressions from their patterns, the need for some form of equipment to carry the various parts will be obvious. Boxes or frames serve the purpose admirably, and, providing they possess the necessary facilities, they are a simple means of separating the mould in such a manner that the sections can be returned to their relative positions without damage to the mould. Apart from their value for lifting purposes, they serve to retain the sand within definite limits, a necessary condition because the mould is produced by ramming the sand about the pattern, a process which spreads the sand outwards, involving some support, such as moulding boxes give, so that the sand can be consolidated regularly. In addition, it must be remembered that metal, when molten, behaves similarly to other liquids, and it applies pressure to the sides of the mould. Thus moulding boxes not only support and protect the sand, during the process of ramming or the division of the mould into sections, but they assist the mould very considerably to withstand the pressure of the metal.

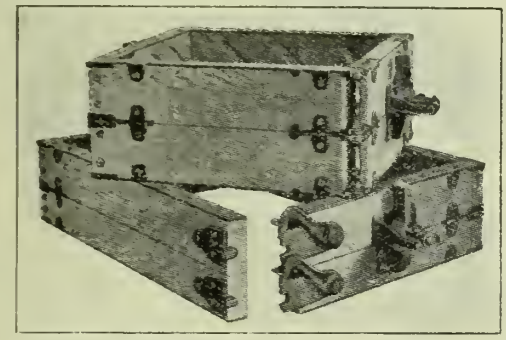


Fig. 1.—Wooden Snap Flasks.

With the exception of open sand moulds, for which the foundry floor is generally used, and a French system, all green or dry sand moulds are prepared in boxes, or the foundry floor may be used for parts of the moulds, to a more or less extent, and the remainder carried in boxes. In loam work no ramming is necessary, and entirely different facilities are required to give the desired support to the mould and the means for lifting, the nature of which will be considered in a later article. Moulding boxes are divided into various parts for convenience in obtaining suitable impressions, pins and corresponding holes being generally used for locating the various parts to form the whole box.

Snap Flasks.

Although boxes must be used to support the sand while ramming, for separation and lifting purposes, they are not always essential during the time of casting. When a large number of small castings are required, snap flasks are frequently employed, particularly when the work in the foundry is of a repetition character, because they curtail the equipment of moulding boxes that would otherwise be necessary. Snap flasks are similar to ordinary moulding boxes, excepting that they are hinged in such a way that they can be removed from the moulds after the moulds have been finally located in their casting positions and before the metal is actually poured. In this way the same flasks or boxes can be used over again as quickly as they can be removed from their completed moulds. Not only is their use economical for certain classes of work, because they reduce the moulding box equipment of a foundry, but they relieve profitable space that would otherwise be occupied by stacks of boxes.

These flasks are usually constructed of wood, with cast malleable-iron fittings for locating the parts, reinforcing the corners, providing the metal hinge, and for the snap clasp at one corner which secures the section until the mould is completed. Although wood is in more general use, aluminium snap flasks are gradually being introduced. Fig. 1 shows the more common form of snap flask, and it will be observed that grooves are cut along the sides of the interior of each part, thus preventing the movement of the part mould in a vertical direction, when the parts are separated. Iron strips are attached to the top of the woodwork to protect it when scraping or strickling off surplus sand. As with other types of moulding boxes snap flasks are made in parts, but the number is limited to two in general practice, and, as no supporting bars can be carried inside to support the sand, their size is also limited.

The use of this form of box is almost invariably confined to machine moulding because they are only advantageously employed on repetition work. Although these flasks are removed from their moulds, some form of support may be necessary to assist the mould to withstand the pressure of the metal during the time of casting, or, even though the lateral pressure may be insignificant, some support is desirable for supporting weights applied to the top to prevent a lift. When the castings are very small, the weight of sand forming

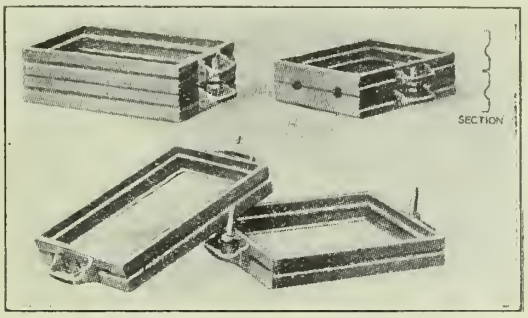


Fig. 3.—Pressed Steel Moulding Boxes (Messrs. Adaptable Moulding Machine Co.)

the mould is generally sufficient, but, when there is a doubt about its weight being enough, it is better to encase the mould with sheet iron. Special cases should be on hand to suit the inside shape of the flask in use.

Ordinary Moulding Boxes.

The general type of moulding box consists of solid frames, varying in the number of parts and in the depths of each part, and, when there is a risk of the sand collapsing in any part, bars may be introduced to give the necessary support. These boxes are made in wood, aluminium, pressed steel and cast-iron, and they may vary in shape according to that of the work for which the boxes are to be used, for the very important reason that it facilitates the operations of the moulder.

Wooden Boxes.

Wooden moulding boxes are more frequently resorted to in jobbing foundries than in foundries producing standard or repetition work, because the wide range of work done demands a considerable variety of boxes, and, although metal boxes are preferred and are made when there is a likelihood of them being generally useful, or when a number of castings are required from the same pattern, yet wooden boxes are so quickly prepared, at little expense, that they are an economical proposition when they are required urgently, or when a similar type of box is rarely needed. A wooden box can, of course, be cut to suit a job much more readily than a cast-iron box, a factor of importance when slight modifications will render it suitable for other work. Although occasionally a full box is made in wood the use of this material is generally limited to the making of cover boxes. The major part of the moulds for which these are used are prepared in the foundry floor and a wooden cover box simply carries the top impression or cope.

They are lighter than iron boxes though not so strong, and they should be constructed to maintain rigidity when they are lifted. An illustration of a wooden cover box, often used for pipe work in jobbing foundries, is shown in Fig. 2. The sides, it will be noticed, are carried beyond the ends of the box to provide handles, and wood bars are introduced at intervals between the sides for additional support to the sand. It is better to leave the timber rough on the inside so that the sand will adhere more firmly. These boxes are, however, clumsy, and being more in the nature of makeshifts to expedite work, they should not be used for heavy or large castings.

Pressed Steel Moulding Boxes.

Mild steel moulding boxes are a more modern product and they are certainly an acquisition to the foundry, being light and almost unbreakable. The frame of each part consists of two pieces of rolled steel, having either a channel section only or grooves in addition, which gives rigidity to the box as well as support to the sand; these two pieces are jointed at the centre and welded, and the joint is strengthened by having the handle riveted over. Thus excepting for the lips, which are cut and welded, the corners are solid, which add considerably to their strength. Fig. 3 shows two forms of steel boxes, one suitable for horizontal casting, while the other can be used for vertical casting. The sectional shape of the steel is also shown. Any number of parts may be employed to suit the work.

Many different forms of these steel boxes are now obtainable, the sectional shape of the rolled steel varying and, in the larger forms, bars are introduced to specification, or they possess facilities for introducing loose bars as circumstances warrant. Mild steel moulding boxes have not displaced cast iron for large boxes, nor are they likely to, because of increased relative cost of production, but we believe that large flat cover boxes may ultimately be made in mild steel if only to reduce the weight of these boxes while still retaining the requisite strength. These boxes are used principally for machine moulding. Aluminium moulding boxes are not used to an appreciable extent, although they offer possibilities for small work because they are light and easily handled.

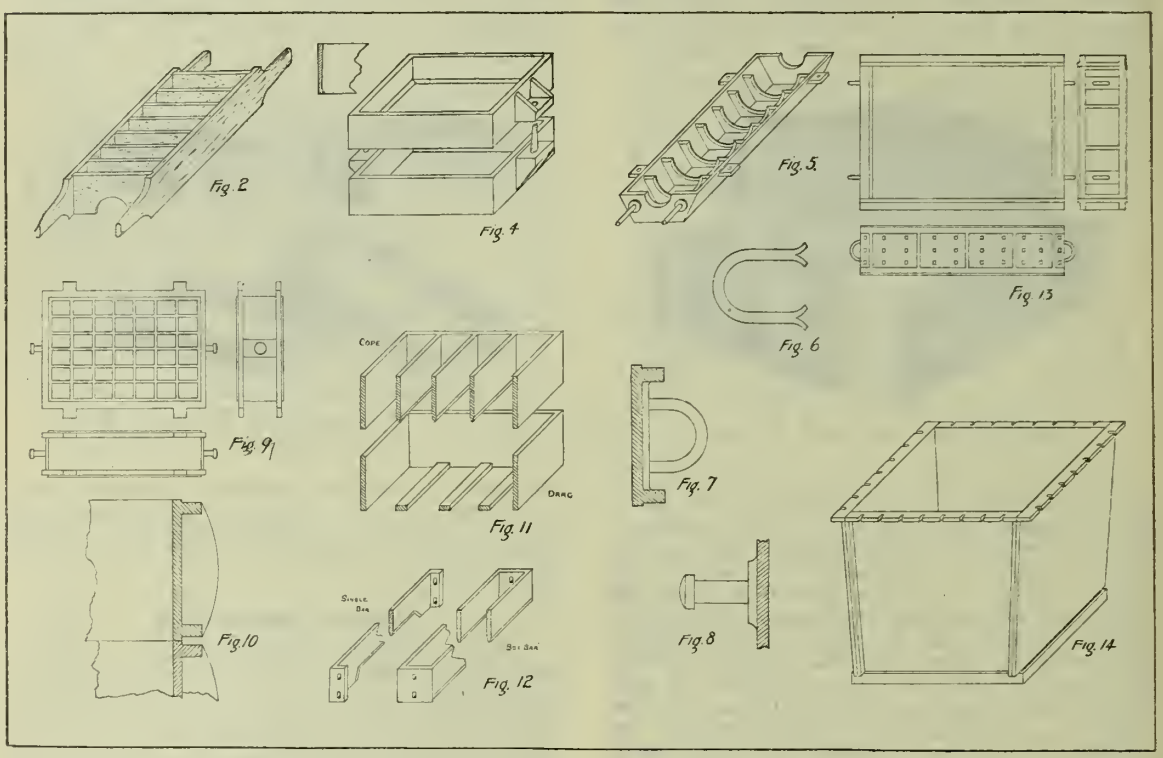
Aluminium Moulding Boxes.

A special adjustable moulding box of aluminium has recently been put on the market, its minimum size is 12 in. by 10 in., and its maximum 16 in. by 14 in., and it is readily adjustable to any size between these extreme dimensions. It is claimed that, where several sizes of boxes are used, the number stocked can be considerably reduced by using adjustable boxes. No doubt such boxes may be profitably used for small work prepared on machines providing that the rigidity at the varying sizes is not affected by continual use.

Cast-Iron Boxes.

With the exceptions mentioned above, the use of which is limited to a varying degree, moulding boxes are generally made in cast iron, and there is no limit to their use. Not only are cast-iron boxes used for small work, but also for the largest moulds made in green or dry sand, whether they are prepared on machines, at the bench, or at the foundry floor. They are strong and rigid, when suitably designed, and they are economically made. Apart from the smaller boxes, which are usually standardised and requisitioned from a manufacturer, moulding boxes are made to suit the work for which they are to be used, either by the foundry requiring them, if an iron foundry, or to specifications supplied to a local foundry. Many steel and brass foundries, however, have facilities for melting iron in order to make tackle, which may be necessary for the moulds being prepared, and sometimes they cast their own moulding boxes.

The designs of moulding boxes vary considerably not only to suit the kind of work and its size, but also to suit the equipment in the foundry, and frequently the particular views of the foreman moulder. A typical example of the ordinary cast-iron moulding box for machine or bench work is shown in Fig. 4. As the sizes increase it is necessary that the box be equipped with bars, and because of the additional weight of the box and sand which it carries, suitable facilities must be attached for lifting and turning over. When hand labour is involved, and either two or four men are essential to separate the parts and turn over the cope, handles should be cast into the boxes at convenient positions for lifting. An example of a two-handled box is illustrated in Fig. 5. It is a type commonly used for pipe work, and it is shaped off to reduce the ramming space. Box bars are necessary in this type of box, parallel with the ends only and about 6 in. apart, according to the width of the box. When the size demands the requirement of mechanical means for lifting, special snugs should be cast on the box or, preferably, wrought-iron staples cast in the box. These staples, to which cranes are slung, are of round material and large enough in diameter to take the weight of the lift with ample security. The ends should be splayed in the manner shown in Fig. 6, and the box side should be reinforced or thickened about the ends so that partial fusion may be effected. When there



is room it is better to cast the staples in vertically, as in Fig. 7, but in shallow boxes they must be set horizontally because of lack of space. With medium size boxes it is convenient to cast trunnions or journals at each end and in the centre, such as is shown in Fig. 8. These are invaluable for turning over box parts and save the work of the crane, besides reducing the possibility of damage to the mould through jolting. The boxes are either supported by standards so constructed that they form a bearing for the journals to enable them to be turned, or special chain slings may be attached to the crane which, when passed over the journals and the box lifted, form a bearance for the same purpose.

Invariably large moulding boxes are flanged externally not only to give additional strength but also to provide a means for clamping the box parts together in order to resist their possible separation, during the time of casting, by the pressure of the metal. Some moulders prefer the flanges plain, while others have equidistant slots cast in them to receive bolts, the choice of which is the better is largely a matter of opinion. A common form of solid cast moulding box for medium-sized work is shown in Fig. 9. It will be noted that the flanges are kept clear from the edge of the box parts in order that a close joint may be more likely to be effected. When it is not possible to use journals for turning the parts of the mould over, an operation which would, with large heavy moulds, probably be risky owing to the strain on the box being localised, curved flanges or rockers are frequently cast on the sides of boxes similar to that illustrated by the section in Fig. 10. These boxes are actually rolled over with the flanges resting upon the floor, when the moulds require to be turned. These are preferable to the straight flanges, because they roll over more regularly with less possibility of jolting.

Box Bars.

Reference has already been made to box bars for giving additional support to the sand, and though, in some cases, there is little difference between the bars introduced in both bottom and top box parts, as a rule they differ considerably. Generally, in a two-part box the majority of the mould is carried in the drag or bottom part, whereas as little as possible is carried in the cope or top part. There are, of course, many exceptions to this rule which will be considered when we deal with the jointing of moulds. To give the box a wider scope for usefulness the drag is frequently almost devoid of bars, and when they are cast in with the part they are invariably flat bars across the bottom, either between the two sides, as shown in Fig. 11, or between both sides and ends according to the area of the box. In the cope, however, vertical bars are used and, instead of being straight, as in Fig. 11, they may be shaped to suit the work for which the box is likely to be used, such as is shown in Fig. 5. The question obviously arises, why is it necessary to have deep bars in the cope when they are almost discarded in the drag? It must be remembered that it is the cope that is to be lifted and turned over, whereas though the drag may be moved for casting purposes, it is not often necessary to turn it over after the pattern has been withdrawn, thus the mould needs less support in the drag than in the cope. In middle parts, that is the term applied to any box part necessary between the drag and cope, the use of bars connecting sides or ends is rarely possible, but small bars may be cast on both sides and ends, their length depending upon the available space between the work to be moulded and the sides of the box part.

Wood Bars.

In many cases the boxes merely consist of frame and wood bars cut and wedged into position as desired or the boxes may have facilities for taking loose cast-iron bars. Both methods are very practical and have a wide usefulness, particularly in jobbing foundries, where it would be absurd to attempt to stock special boxes for every class likely to be done. Wood bars are usually employed with smaller boxes, but they are not sufficiently rigid for large boxes. Cast-iron bars can only be used satisfactorily when holes are cast through the sides of the moulding box, corresponding holes are cast through flanges on the bars so that they can be bolted in position.

Box Bars.

Either single or double bars—generally referred to as box bars—may be employed, as shown in Fig. 12, but usually box bars are stocked, whereas single bars are cast as required. Loose bars are very quickly produced to suit any work for which the frame box can be used, and the contour can be made to follow that of the work. It is important to remember that there should be at least ½ in. of sand between the edge of the bar and the face of the mould, against which the metal is to be cast, and the edge of the bar should be well chamfered on each side, as shown in Fig. 12, so that the sand under the bar is accessible for ramming to an equal density to that elsewhere. All bars which are to be bolted in position should be cast at least ¼-in. shorter than the inside width of the box, so that it can easily be located.

Sectional Boxes.

Solid boxes which are stocked in a foundry occupy much valuable space, and when there is little room for expansion, as much available space as it is possible to obtain should be made profitable when the occasion demands it. Sectional boxes do much to assist in using the available space more effectively. They are particularly suitable for large and medium-sized boxes. Sides and ends are made separately and bolted together when required. Separated sides and ends take up much less space than a solid cast box, and if the sides and ends are standardised for varying depths, boxes can be assembled according to requirements. It is desirable to keep a stock book showing the sizes of available sides and ends so that no time need be wasted in sorting out. This applies also to box bars, which must be loose for sectional boxes. The time taken in assembling a sectional box is frequently looked upon as a serious drawback, but that depends upon the organisation of the foundry, and, it must be confessed, that the same drawback can be applied to solid boxes, particularly when it is necessary to search the railway siding, the favourite dumping ground for moulding boxes. An illustration showing the formation of a sectional box is indicated in Fig. 13.

Cases or Pits.

In many foundries a considerable amount of work is done in the foundry floor. In some instances it is quite satisfactory to dig a hole and use the compressed sand of the floor as a support for ramming the sand of the mould which is to be made in the hole or pit, but, when work is large and dry-sand moulding is involved, it is better to sink a moulding box in the floor, and it is preferable that the bottom be of metal also, in order that the mould may be self-contained and not subject to influences over which the moulder has no control. Leaky pipes may flood a mould ready to be cast or dampness may be absorbed to such an extent that, not only would it be a danger to the resulting casting, but it would imperil the lives of the men engaged in pouring the metal. These cases, as they are called, are now in common use, their sizes varying according to the particular work for which they are required. In foundries where large castings are made, at least one very large case is sunk in the floor to accommodate exceptionally large work, but partitions should also be prepared in order that it may be used for smaller work when not fully occupied with a large job. A modern form of case suitable as an example is shown in Fig. 14. It will be noticed that the area is larger at the top than at the bottom, in the older forms the sides were parallel and they offered considerable resistance to the withdrawal of the work after it had been cast. The tapered sides reduce this difficulty, and, incidentally, much of the sand is removed with the casting, which is an economical consideration. In order to make the cases watertight the bottom plate is flanged externally, a clearance of at least ½ in. being allowed between the case sides and the flange, which is rammed up with iron borings to which sal-ammoniac has been added, so that a rust joint is formed.

Box Pins.

The time was when the correct relative positions of box parts were located by means of marks made on a daub of loam, and while it was not considered

to be good practice, at all events it was considered to be passable. To-day considerable attention is given to the degree of accuracy by which box parts register. Fins on a casting can be excused; as a matter of fact, in many classes of work they are an advantage, but an overlap due to defective fitting pins is a source of discredit. The amount of clearance between the pin and pinhole should be as small as is possible for a clean lift. Smaller boxes can do with less clearance than larger boxes because they are more easily located in a horizontal direction. The pins should be tapered so that they engage easily. The sectional shape of pins varies to a certain extent, thus on wooden snap flasks it is usually triangular, but the more general shape for ordinary boxes is round. Other shapes have been used with varying success, but the circular pin predominates. The most convenient number of pins on a box is frequently a debatable point, but the smaller the number the smaller the clearance that is necessary, thus for small boxes two pins suffice, while four should be used on large boxes as a means of gauging the cope parallel with the drag as well as to register the parts accurately. There is the difficulty with an even number of pins, that are on the centre or symmetrical about the centre of the box, that they are not fool-proof, they may set the wrong way with disastrous consequences to the mould or to the casting. Many efforts have been made to circumvent this danger without adding another pin—a practice which has fallen into disuse—by altering the shape of one of the pins, in the case of a two-pin box, or by varying their positions on a four-pin box, so that they can only be assembled in one way, but with little effect on the general practice.

Many contrivances are adopted for making use of the pins to secure the parts together to resist the pressure of the metal. In some instances slots are cut through the pins to receive cotters or wedges, in others the pins have a lip or flange at the top which passes through a slot hole in the lug, and wedges are introduced between the projection on the pins and the lug. We are of the opinion, however, that pins should be used for registering only, as knocking them about with wedges does not improve their degree of accuracy and the boxes are quickly rendered unworkable.

Another form of guide is necessary when the foundry floor or a case is used for the mould to locate the cover box accurately. Iron stakes are used for the purpose, either square or round bar iron or angle plate may be used. They are driven into the foundry floor and allowed to project in such a manner that they are in contact with the cover box. At least four are necessary, but frequently more are used.

Contracts Open.

Birmingham, August 29.—Supply of about 2,400 tons of 18-in., 24-in., 27-in., 36-in., and 42-in. vertically cast S. and S. iron pipes, each 12 ft. long, and irregulars, for the Corporation. The Distributing Engineer, Gas Department, Council House, Birmingham.

Bombay, October 10.—Supply of galvanised pipes and fittings and gunmetal ferrules, taps, etc., for the Municipal Commissioner, Bombay. The Storekeeper, Storekeeper's Office, DeLisle Road, Byculla.

Brighton, September 18.—Supply, delivery and erection of two water-tube boilers, with superheater, economiser, steel chimneys, etc., for the Corporation. Mr. J. Christie, Electricity Department, North Road, Brighton. (Fee £2 2s., returnable.)

Melbourne, January 15.—Supply of four water-tube boilers, each 4,500 sq. ft., with pumps, piping and structural steelwork for boiler house, for the Victorian Electricity Commission, 22, William Street, Melbourne.

Pinchbeck, Lincs., September 2.—Supply of about three and a half miles of new water mains, 3-in. diameter, for the Spalding Rural District Council. The Clerk, Spalding, or Mr. E. J. Silcock, 10, Park Row, Leeds. (Fee £5, returnable.)

Wetwang, Driffield, September 6.—Construction of an underground rain-water cistern in reinforced concrete at Wetwang, for the Driffield Rural District Council. Mr. G. Harker, clerk, 17, Exchange Street, Driffield.

Messrs. Daniel Adamson & Company, Limited, of Dukinfield, near Manchester, have received an order for one of their latest patent electrically-driven crude sewage lifting plants for Messrs. Cropper's new factory at Thatcham, Berks.

A New Puddling Process.

In a recent issue of the "Iron Age" a new mechanical puddling process is described.

The principle of the process, which is the invention of Henry D. Hibbard, is in making a charge of molten iron and oxide of iron pour repeatedly over a dam. An intimate mixture of the two ensues, with a rapid change of the iron to the wrought state. The presence of this dam causes the material to spill over the top in a thin stream as the furnace is oscillated back and forth in operation. This makes for thorough mechanical mixing, and goes far to explain the homogeneity reported in the product.

The melting stage is carried on in a cupola, as considerably less expensive than melting in the puddling furnace. From Fig. 1 it will be seen that molten iron goes into the furnace through one hollow trunnion (the oil fuel is introduced through the other trunnion) and the purifying, boiling and balling stages take place within the furnace. In all three of these the operation, mechanically, follows the hand method, both in the chemical and physical aspects. The carbon is removed, just as in the hand method, during the boiling process, while in the balling process the plastic grains unite and form the sponge. A mixture of grey forge pig-iron and scale is used.

Essentially, the furnace consists of a cylinder of steel plate about 6 ft. in diameter and 5 ft. 6 in. long, with projecting trunnions 18 in. in diameter. The cylinder is lined with magnesite brick to an

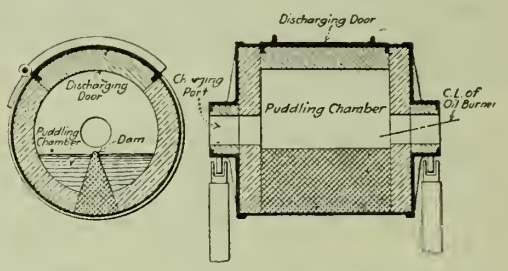


Fig. 1.—Puddling Furnace Incorporating the Principle of Mixing by the Dam Shown. The Ball is Removed by the Discharging Door.

inside diameter of about 4 ft. The dam, which consists also of magnesite brick, extends up nearly to the centre line. On the surface of the brick a skim of iron is sintered to perhaps ½ in. As this protects the brick both from mechanical damage and from the action of the hot metal, the refractory situation is reported as not causing trouble. The operation is carried on at a temperature of about 1,455 deg. C., the flame being 1,565 deg. As soon as the iron "comes to nature" and begins to form into a ball, the oscillating motion of the furnace is stopped, and it is rotated clear over. Eventually the door, which normally is at the top of the furnace, is opened, and out of this door the balls drop upon a conveyor.

Some of the physical and chemical results obtained from this iron are shown in the table. The iron is used largely for pipe and sockets, for engine bolts, stay bolts and high-grade merchant bar. It is reported that the chemical analysis presents great uniformity from one heat to another.

	Pipe and Socket Iron	Stay Bolts and Merchant Bar
C. per cent.	0.022	0.030
Mn, per cent.	0.031	0.022
Si. per cent.	0.220	0.200
P. per cent.	0.128	0.042
S. per cent.	0.025	0.013
Tensile strength, from ..	20.0 tons	21.4 tons
to ..	22.3 tons	23.2 tons
Yield point, from ..	11.2 tons	11.6 tons
to	13.4 tons	14.2 tons
Elongation, per cent. (in 8 in.)	15 to 20	25 to 30

The patents of this process, which are world-wide, are being exploited by the Hibbard Process Corporation, 71, Broadway, New York, U.S.A.

Small Runners and Sound Castings.

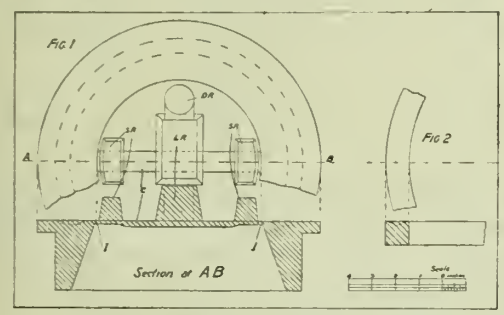
By Ecossais.

The writer has followed with interest the recent articles and papers on the methods of producing sound castings without feeding heads by the use of small runners. Many foundrymen of experience would be able to confirm the good results obtained by a careful review of their past experience, tending to prove that while the application of small runners systematically may be a novelty, the results themselves have been obtained years ago. The very people who obtained the results, however, would have ridiculed the idea that small runners had been the means, or, in fact, had anything to do with these same results.

Cylinder Liner Practice Detailed.

Mons. Ronceray has asked that foundrymen should experiment and make public their results. However, by carefully examining past work most foundrymen could give instances similar to the one it is proposed to detail.

It is common practice in casting hollow, cylindrical castings as liners to have a sink head to ensure soundness and receive the scum which forms on the top of the metal, due to the agitation caused by the falling and splashing of the metal from the runners, which are generally much smaller than would be used were the casting poured horizontally. Although a liner, being of fairly uniform thickness, could not be compared with a more complicated casting, still, in comparison of a number of liners cast with similar metal, some uniformity should prevail, unless some other factor was present to affect results. In this connection the writer has seen widely different appearances in the heads, after removal of liners of the same



size and metal, cast in dry-sand moulds. Some would have a distinct pipe, open at the top of the head, others apparently would be quite solid but with rounded edges. The latter would apparently be explained by a later occurrence with a smaller liner. This had a somewhat larger core than the prints provided for it, with the result that there was a tendency to crush when the top half of the box was put in position. When turned on end for casting, the runners, three in number, were only about half the thickness they were intended to be, and there were doubts as to whether some of the prints had not crushed in clamping up; also as to whether the mould would fill. However, the metal was poured and went in extremely slowly, and apparently was hopeless. When knocked out next morning, the feeding head, usually 6 in., only measured 4 in. The top was apparently solid, but the edges were round, as if the metal at the top had been fairly dull, though the casting machined perfectly. Turning back to the larger liners, the writer can only form the opinion that the liner heads not showing a pipe had smaller runners than those with the pipe, which accounted for the rounded edges. As all the runners were cut out by hand, this could easily occur, and in the event of a loosely-fitting core, the area might be easily doubled or trebled, a fact best known to the man who cast them by the ease or otherwise of "keeping up" the runner.

Method of Casting Detailed.

Fig. 1 shows a half-plan and section of a casting which some two years ago gave a little trouble. These were cast in close-grained, low-silicon iron, when cast by sprays on outer circumference, almost always showed depressions, as indicated in sectional view by dotted lines; even when three risers of 1¼ in. diam. were placed on top, the results were not too good. After a little experimental work the design of runner shown in the centre of the ring was decided upon.

The top part of moulding box was 5 in. in depth and a well was scooped out, to supply the down-runner DR, 1¼ in. dia. This was connected direct to the large reservoir LR and by the channel C in the drag part to the smaller reservoirs SR. The metal entered the casting at points I, the channel C having been contracted to a depth of 3-16 in., being ⅜ in. wide, a kind of half-round spray, the sectional area being equal to that of a segment of a circle with a ⅜-in. chord and a segmental height of 3-16 in. This was certainly a very small runner as compared with original runners. The three reservoirs in the top box were all pattern-made, the connecting channels being cut by hand.

With the runners shown, defective castings rarely appeared, except very occasionally, and due to dull metal, wet sand, or too hard a face. With the stiff metal there would be a misrun, and in the other cases blowholes would be plainly visible. These castings machined up perfectly sound, and several were broken and did not show any signs of "sponge." The results being so good, the same type of runner was tried on the gear blank ring, shown in Fig. 2, which with the metal used had given trouble owing to slight depressions appearing on the face of castings. With the above type of runner this trouble was also overcome.

The writer was puzzled to account for the success of the runner, which could be described as more or less accidental, the intention being to provide four large lumps of greater section than the casting, and at a short distance, say ⅛ in. from it, connection being made by a small ingate. Space did not allow four, and eventually it dropped to two, with a central feed, these being reduced in size by the moulder because they weakened the top box, until the section shown was reached. Obviously they do not act as feeders, but keep the metal hot enough to flow through the small inlets I.

Theory Discussed.

Therefore, on reading the articles dealing with castings without feeding heads, the writer was convinced, and now supports Mons. Ronceray when he states that "there is something in it." With a casting with a relatively large surface area and slow filling, the metal would require to be exceedingly hot, and the cope well reinforced, or there would be a misrun on the one hand or a collapse of the cope on the other. It has been customary for many years with certain jobs made by piece-workers to put very small ingates to castings for the sake of prolonging pouring. These would ordinarily have been cast with dull metal, but which, owing to the workman's eagerness to get good casting, are cast as hot as can be obtained from the furnace. The result is solid castings are obtained. These castings would certainly have sunk if cast so hot with a gate of ordinary size. Evidently, with a gate of large section, and metal passing through rapidly at a high temperature, that portion becomes superheated, to a greater extent than can possibly occur with a small channel, which by gradual filling tends to confirm one writer's theory that the temperature of the mould at all parts is approximately the same.

[It is not quite clear whether the author intends to convey the idea that the making of small area gates would give the moulder the right to demand hotter metal, or the surface area of the runner being so much less would extract less heat from the metal in passing through it. A smaller channel would more rapidly be heated to the temperature of molten iron, and when this temperature is reached the extraction of heat would be negligible. With larger-sized runners, although the passage of the metal is quicker, the extraction of heat would be greater.—Editor.]

British Engineering Standards Association (28, Victoria Street, Westminster, London, S.W.1).—This Association has issued among others the following Standard Specifications for Aircraft Material:—No. 2 A.3, Straight Steel Eyebolts for Flexible Steel Wire Rope; S.40, Extra-High-Tensile Alloy Steel Strip; S.43, Medium-Tensile Alloy Steel Strip; S.46, Nickel Steel Strip; 2 T.4. Wrought Light Aluminium Alloy Tubes (Duralumin).

Plaster Patterns.*

By C. HEGGIE (Oldbury, Birmingham).

Material Used.

Plaster of Paris, or stucco, as it is more commonly called in Scotland, is obtained from gypsum, a mineral of comparatively soft nature. Chemically it is a hydrated sulphate of lime, $Ca SO_4 2H_2O$. It contains roughly 21 per cent. of water, or say, four-fifths sulphate of lime and one-fifth water. Usually it also contains 10 per cent. calcium carbonate, not necessarily in intimate union with the sulphate, but interspersed in grains. The water of hydration was driven off by baking, and the residue was then ground to what was known as plaster of Paris, which he understood was now recognised as the hemi-hydrate $2CaSO_4H_2O$. This substance still contained 7 per cent. to 8 per cent. of water, and it had the most valuable property of being able to re-combine with water to form a soft paste, which could be run or strickled to the desired shape before becoming hard. When the plaster was added to the water it dissolved and formed a saturated solution. The solution was super-saturated in respect to the hydrate, and some of the dissolved salt separated out in the form $CaSO_2HO_{\frac{1}{2}}$, thus setting free some of the dissolving water to dissolve more of the plaster, the process being repeated until the mass became set. After setting it must be considered a solid solution of $Ca SO_4$ in water, the particles of plaster being converted into a network of crystals, mechanically enclosing the remainder of the water. There were many kinds and qualities of the plaster, the three most common being superfine, fine, and coarse, but most shops stocked only fine and coarse. Only those two were necessary, except, perhaps for high-class ornamental work. Some splendid work could be done with the fine material, which could be improved, when necessary, by passing it through fine sieves. The coarse plaster is used to run up the pattern blocks or the heavier class of patterns where the thickness or section was suitable. Such patterns and blocks are usually finished with a coating of fine plaster. The quality of the powder can be tested by squeezing it in the hand, much in the same way as sand was often tested. Good plaster would cohere slightly when the hand is opened; otherwise it would fall to pieces, generally indicating injury by damp. It should be kept in a metal or wooden box with a suitable lid, to protect it from dust and damp. The addition to the box of an inside hopper and sliding scale was an improvement, as by this a minimum exposure was obtained. The vessels used for mixing should be free from sharp corners, and with well-tapered sides if at all deep. A basin-shaped vessel with a handle and two small spouts for pouring was best of all, because it was easily cleaned and it exposed a large surface of water when the plaster was being added. The vessels should be kept clean and fresh, and clean water always used.

Mixing.

In regard to mixing, no hard and fast rule could be laid down as to the proportions of water and plaster; each job must be considered on its own merits. But, speaking generally, a mixture of a consistency equal to that of a good cream would give the best results. The water must be first placed in the vessel, and the plaster then added. It should be sprinkled well over the water, giving it every chance to dissolve thoroughly. The addition of the powder should be continued in this manner until it was seen in a small pile over the water. It should then be quickly stirred, but excessive stirring weakened the mixture. Nor should plaster or water be added after mixing, as the plaster was thereby weakened; additional plaster evolved heat, and caused swelling and warping of the pattern. He had made no recent experiments as to the proportions of water and plaster, but the figures he gave on the previous occasion were arrived at after careful trials, and he had no reason to doubt their accuracy. The method of testing was to push strips of plaster over the sharp edge of an iron plate until they dropped off, and then find the length of the part broken off by measuring the remaining piece. Two sections were used, $\frac{3}{4}$ by 5-32 and 1 by $\frac{1}{4}$. To decrease the length of the pieces broken off so that shorter test pieces could be used a weight was suspended from one end. In the first case it weighed $\frac{1}{4}$ lb., in the second case $\frac{1}{2}$ lb. The results were summarised in the following table:—

Proportions of Water and Plaster by Weight.

	W. P. 8 6	W. P. 8 8	W. P. 8 10	W. P. 8 11	W. P. 8 12
Section $\frac{3}{4}$ in. × $\frac{5}{32}$ in. (weight $\frac{1}{4}$ lb.)					
Hours.					
2 ..	2 in.	3½ in.	4⅛ in.	—	5⅛ in.
26 ..	3⅝ in.	6⅜ in.	7½ in.	—	9¾ in.
Section 1 in. × ¼ in. (weight ½ lb.)					
2 ..	3¼ in.	5 in.	7 in.	7½ in.	8⅛ in.
26 ..	3 in.	4¾ in.	6⅝ in.	7⅛ in.	8⅛ in.
Carelessly Mixed and Overworked Plaster.					
Hours.					
2 ..	—	—	—	—	4½ in.
26 ..	—	—	—	—	4¼ in.
With Lime.					
2 ..	—	5½ in.	7⅛ in.	9⅞ in.	8⅜ in.
26 ..	—	5¾ in.	7¼ in.	9½ in.	9¾ in.
With Alum.					
2 ..	—	4⅜ in.	5⅜ in.	—	8 in.
26 ..	—	3⅜ in.	5½ in.	—	6¼ in.

Though these figures might have no real value in themselves, they indicated that correct mixing and proper proportions are essential to a sound job. It is also essential to do the job quickly and, where possible, with one mixing of the plaster. Continual mixings and an excessive use of the template made the patterns weak and rotten.

Demands for Various Work.

In large work, where the mixture would be likely to set before completion, setting could be retarded by the use of several materials such as lime, size water, ammonia, and sulphate of zinc. The most common was lime. It should be slaked in a separate vessel, and the lime water used after passing it through a fine sieve. It was said that this also hardened and strengthened the work. Alum water was also used to harden the work and quicken the setting. Like lime, the alum should be dissolved in water, and the solution added to the neat water and stirred before adding the plaster.

For solid round patterns of an ornamental character plaster of Paris would in many cases give quicker and more accurate results than by turning the pattern in wood.

For fine and accurate work it was customary to use sheet zinc for the templates. Two pieces of zinc were cut to the necessary size, and the outside shape of the pattern was marked out on one of them and carefully filed to the drawing; the second piece of zinc, used for running the block which formed the inside of the pattern, was marked off from the first, less the thickness of metal required. It was advisable to fasten the two together (a stitch with solder was customary), and drill screw-holes for fastening to the strickle. The block template could then be finished accurately, as the thickness of metal could be measured from the face template. When the block had been run up the template was removed and the face template replaced, the screw-holes ensuring the correct position. In work where the finish was not so important, and when the template was not

* A Paper presented before the Lancashire Branch of the Institution of British Foundrymen. The Paper was illustrated by lantern slides and practical demonstrations given, in which the author was assisted by Messrs. Christie and Robinson.

likely to be again required, the strickle was cut to the required shape, the thickness being cut out after the block had been run up, as was done in loam work in the foundry.

Special Cases of Templates.

For a 6 ft. gutter, the block was first run up, and then varnished with ordinary shellac, and oiled. As a rule zinc templates were used for this class of work. It was usually necessary to sweep or camber the plaster patterns to ensure a straight casting, owing to the irregularity in the cooling of the iron patterns and the castings from it. Instead of sweeping the board to the desired curve, the ordinary practice was to use a straight board and place upon this strips of wood termed risers. These were planed to the required sweep, and the strickle took its bearing on them, the edge of the strickle engaging with the edge of the riser. In the case of a circular gutter the edge of the riser would be curved to the necessary radius, the edge of the strickle engaging with this in the usual way. These risers could be easily altered or replaced to suit the necessary cambers for the varying sections of the patterns. The gutters were made from 1-10 in. thick, and for convenience in handling the plaster was usually cut longitudinally in two, the two portions being afterwards cut into five or six pieces.

Many straight patterns made as described were not complete in themselves, castings being made from them in some of the white-metal alloys. These were finished by filing and chasing, and were then soldered together to form the complete pattern. In many cases, however, the "plasters" might be assembled to form the pattern.

Circular Patterns.

The production of circular patterns in plaster was simple and cheap, and a regular thickness was assured, while to build and turn up the same in wood would take a fair amount of time and be more expensive in material. Fine plaster in the form of patterns cost about one-half as much as the best yellow-pine for the same number of cubic inches. As a rule, there was the initial expense of an own pattern, which, however, had many decided advantages over one of wood. One of the greatest disadvantages of the latter was its liability to warp.

Large Blocks.

Where large blocks were required it was usual to reduce the weight by packing up with material of lower density. Wood lagging might be used, but its tendency to swell and warp when in contact with the plaster made it undesirable. Even where the wood was thoroughly soaked before using there was still the risk of the block becoming warped when the wood dried. The most common practice was to use coke. The coke was built up so that a suitable thickness of plaster, say ¾ in., could be run on the top of it. A wood centre block is screwed to the board and carried the socket or plate in which the pin of the strickle revolves. Sometimes the strickle is made in two pieces and jointed, simply for strength and to save material. There was a centre line on the plate, so that it might be screwed accurately without trouble. The zinc template would be used for this, but the wood was bevelled well back, leaving the actual cutting edge. The face and edge of the template should now be varnished and oiled, as should also be the back of the template on the board. Besides assisting a freer movement this facilitated the more ready removal of the superfluous plaster. After ascertaining that the position of the template would give the required diameter the plaster was mixed and the block run up. The thickness of the metal must now be cut from the template, the block being touched up where necessary and varnished and oiled. Very little oil was needed. Beginners often used it in excess, with the result that it collected in angles and corners, causing them to be blunt and rounded when they should be sharp. It should be noticed, while strickling, that no part was being missed, as this neglect might create a necessity for additional mixings of plaster and a prolonged use of the template over the whole job, adding to the expense and detracting from the quality of the work. All these patterns were cut into suitable pieces for handling by the moulder.

In running a bead on to plaster already partially set, the plaster should be roughed and damped. The new plaster would adhere very much better if this was done.

The spindle and swing centres were useful for the making of pipe faucets and spigots and other round work. With the swing centre a half-pattern only was made, and in many cases this was all that was necessary, as both iron halves were the same. These patterns were used chiefly as shell patterns, but when core boxes were used they were made from the same plaster.
on the vertical spindle.

Guide and Track Work.

One of the most useful methods of plaster-pattern making was guide and track work. The principle was to supply a guide or track for the template. All sorts of irregular-shaped work could be made in this manner. A good example is a triangular plate with a moulded edge. On the board is fixed a riser strip, the edge of which acted as the guide for the template. Only one block was run up, and this was used to run the three sections on which, when joined together and placed on the foundry board, formed the complete pattern, the block being broken up and the parts distributed to support the pattern. Other examples of this class of work are a pillar guard, the leg of a mantel register, and the end of a cast-iron column for a pier.

The making of ovals might well come under the name of "track work," although it was more on the principle of circular work. Take a simple oval frame 3 ft. x 2 ft. A wood strickle and zinc template would probably be used, and the centre line marked off at half the length of the major axis, 18 in. A second centre line would then be marked off at half the length of the minor axis, 12 in. or 6 in. distant from the first. Two centre plates are screwed on at these positions. In the board, or in a plate screwed to the board, two grooves are cut at right angles to each other and of a size suitable to form a sliding fit with the centre pins, or with loose slides in which the pins fitted. As the strickles are moved round the centre pins travel along the slots, one in each, so that by the time a quarter of the oval has been run, the template has travelled 6 in. nearer the true centre of the oval. An oval lavatory basin would be treated in much the same way, the slotted plate being carried by a wood centre screwed to the board. In large oval work the cross could be carried by a wooden frame, built outside the track of the template. In such a case the template would be suspended from the cross by two bolts, which took the place of the pins used in smaller work. Sometimes the templates were fitted with wheels to give an easier movement.

The patterns already discussed have been finished direct from the template, but there are cases where this could not be done. Parts had to be pared to shape, additions made, curves altered by hand or by the use of further templates, etc., and the whole assembled and made ready for the foundry. In the case of a fluted dome, the block is run up in the usual way, but the flutes have to be pared. The flutes on the block are carefully marked—the template being used for this, as the lines are radial—and then hollowed out. This forms the back or inside of the pattern. Before running the thickness, centre lines must be marked on the board to ensure the flutes being marked and pared in the pattern exactly over those already made in the block.

Three-Way Pipes Considered.

A three-way pipe is another pattern that must be partly shaped by hand. The sockets might be run up on the spindle, or with the template swinging on centres. In most places iron standard sockets would be used. The 12-in. and 7-in. dia. pieces would be run up on a straight board, as would also be the core-prints. On the top of the core-print an extra thickness should be run, this to be used later when altering the pattern to the core-box. The whole is then placed in position on the board, care being taken that the centre lines of the main pipe and branch pipes are correct, as both halves of the pattern are made from this. The centre part of the block is now filled in with additional plaster and finished off to shape. The thickness to form the pattern is then poured on, small pieces of wood equal in thickness to the metal required having been pre-

viously placed on the block as a guide when this part is being pared. When the half-pattern has been cast, the plaster is altered for the core-box. The pieces which were run on the top of the prints are now placed in position, the prints themselves becoming the block for same. The outside of the pattern is then strengthened by strips, etc., snugs put on for pins and handles, and the two halves of core-box cast from it. In many cases of this class of work shell patterns are made and no core-box used.

Locomotive Domes.

Another interesting example of circular work where parts had to be pared by hand is the making of locomotive domes and chimneys. In the making of the bottom part a board was first prepared, 6 in. or so larger than the diameter of the base. A block of wood to act as the spindle, and with the plates or socket for the pin of the strickle already in, was then fixed to the board. Centre lines were projected on to the board from the centre of the spindle. The spindle is then removed for the time being, and two wooden strips, curved to the radius of the boiler, are screwed to the board at a distance greater than the diameter of the base, and central with the lines on the board. A piece of wood slightly larger than the diameter of the spindle, and less than the height of the strips, was then fixed at the centre of the board, simply to keep a hole clear for the spindle when used later. The space between the wood strips is then filled up with plaster and scraped off with a straight-edge to the curve of the strips. This plaster block was pared to a diameter slightly larger than the base, and the spindle was replaced in the board. A strickle having been prepared to the inside shape of the dome, the plaster base is varnished and oiled, and the block forming the inside of the pattern is run up. On this four or eight vertical lines—the more there were the more accurate would be the job—were projected, the strickle being used to mark them off. The block is then pared and gradually worked in to the curve made by the strickle. When the whole of the block has been treated in this way, the required thickness of metal is cut out of the strickle. Small pieces of wood, equal in thickness to the metal required, were distributed over the pared curve, and these act as guides when the outside is being pared later. The thickness or pattern is run on and the curves pared as before. Other parts of the pattern, being circular, are run up in the ordinary way. The iron patterns, after being filed or turned, are used as shell patterns.

Other Uses.

Plaster could be used in many ways other than making complete patterns. Perhaps a large quantity of core-prints are required, snugs, small ornaments, etc. By making two or three, according to the size of the print or ornament wanted, and casting a plaster mould from them, plaster casts of the required part could be produced quickly and with assured accuracy.

Perhaps the most useful of the more simple plaster jobs is the familiar odd-side. By having the two odd-sides, one cast in plaster on the top of the other, accurate joints are obtained, and the tops and drags can be made from them on bench or machine. In such case, the patterns, of whatever material they were made, would be used on the odd-side. Plates could be made completely of plaster in the same way. To make a complete reversible plate—by which is meant a plate from which both top and drag were rammed—the method is much the same as that used to make such plates in cast-iron.

The moulding-box would have a centre bar, and the complete sand mould would be made in the usual way in one of the divisions. A similar box or frame for the plaster was placed on one part of the mould, and plaster poured over this in one of the divisions. When the plaster is set, the frame is removed and placed on the second box, with the remaining open space over the mould. Plaster is poured over this, thus giving a complete plaster plate. Projections, corners and other weak parts that might easily be broken are often strengthened by white metal. This could be nailed on or placed in the mould before the plaster was poured in.

With regard to the following notes, the author cannot guarantee their accuracy, but thought they might be useful for experimental purposes to those interested.

The addition of 5 per cent. of cornflour rendered the plaster hard and tough. Pulverised marshmallow roots, or water in which they had been boiled, added to the extent of 4 per cent., retarded setting for an hour, and then it could be filed, sawn or turned. Eight per cent. further retarded setting and increased hardness. Plaster casts could be hardened by soaking in a strong solution of alum. This, in combination with the marshmallow, made plaster as tough as wood and as hard as stone.

Discussion.

The Chairman (Mr. W. H. Meadowcroft) said the members were not all concerned with plaster work, but many things connected with it were applicable in ordinary sand moulding. This was a unique opportunity of seeing it actually demonstrated, and everyone must have found it interesting.

Mr. McLoughlin asked how Mr. Heggie would proceed in the case of a fillet between two right angles. Would he use any wood at the corner, or simply fill up with plaster?

Mr. Heggie said, in an ordinary way, he would not use any wood, but simply a few sprigs driven in to hold the plaster at the edge. Where the plaster was thin at the edges a groove in the wood thickened the plaster and strengthened the job.

Mr. Hogg moved a vote of thanks to the lecturer, to the demonstrators, Messrs. Christie and Robinson, for the admirable way in which they had illustrated the mixing of the plaster and the production of the patterns, and to Mr. Clayton for bringing the materials. They were all members of the Institution, and this meeting was a signal proof of the good work which was done by it. One firm, which went in for fancy brackets and ornamental work, never put it into wood; they made plaster patterns and sent them out to the foundry to be reproduced in iron or a non-ferrous metal as soon as possible.

Mr. H. Sherburn said he had been closely associated with work of this kind for many years, and he had often wished to bring it up at a meeting of the Branch. Now that the members had heard Mr. Heggie's lecture, and seen the amount of preparation which had been necessary, they would understand why he hesitated to undertake the task. It would be an excellent thing if a similar demonstration were given through the Institution. To many engineering pattern-makers the methods adopted might seem to be unorthodox, but in many cases they were far more mechanically accurate than any other known process. If the pattern-makers would give heed to what had been said that afternoon, they would find their work would become easier, and perhaps in some ways pleasanter. Many castings that were now made could not have been produced if the system outlined were not available, and they were deeply indebted to Mr. Heggie and the demonstrators for the lucid exposition which had been given, which had been full of interest, and would doubtless open new possibilities of pattern work to many of their members.

Mr. Simkiss, in supporting the vote of thanks, said plaster patterns were by no means a new thing. In Manchester, a few years ago, a lecture was given on the subject, and for some time afterwards a quantity of such patterns were produced instead of wooden patterns. Some were similar to what Mr. Heggie had shown on the board. They were of rather large dimensions, and more costly to produce castings from; therefore prices went up, and to some extent that stopped the making of plaster patterns. He had heard of Keen's cement being used, but he had no experience of it personally. Perhaps Mr. Heggie could tell them something about that. Unless plaster was handled rapidly, it lost its nature, and could not be induced to set hard under certain conditions; mixed with Keen's cement, one had more latitude as to the time.

Mr. Heggie said he knew Keen's cement was used in conjunction with plaster, but he had not made any experiments with it. He had always found that plaster was quite good enough for the work that he did.

The vote of thanks was passed unanimously.

Eliminating the Gas Regenerator Chambers in the Open-Hearth Process.

In a Paper read before the American Foundrymen's Association at its recent annual convention, Mr. Willis McKee, after describing the use of the blow-torch or Bunsen-burner principle in its application to open-hearth furnaces, remarks that this process of combustion has opened up quite a number of possibilities for the further improving of open-hearth construction which deserve serious consideration. In Fig. 1 is shown a part section of an open-hearth furnace in which the regenerators are encased with insulating bricks and steel platework. Inasmuch as the use of the steel platework enables the use of much thinner walls, it is evident that this construction is little more expensive than that which is now used, while the saving due to decreased heat losses is appreciable. Furthermore, the regenerator chambers can be maintained in much better shape and the temperature of the basement is materially decreased, making it much more livable.

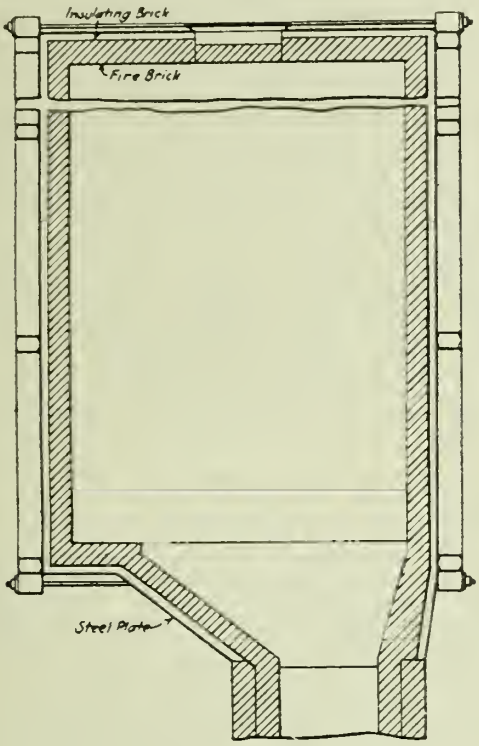


Fig. 1.—Steel-Encased Insulated Regenerator Chamber.

A more radical departure is the eliminating of the gas regenerator chambers when using producer gas, as shown in Fig. 2. It is proposed to locate the gas producers comparatively near to the open-hearth and conduct the gas in suitable steel mains, properly insulated, to the ends of the furnace and introduce the gas into the air uptakes without any regeneration. This practice becomes possible only by the use of the blow-torch principle, where the air and gas thoroughly mix before they issue from the port so that the resultant temperature of the mixture is the only temperature that needs to be considered. Inasmuch as approximately 800 deg. Fah. stack temperature is now obtained in a blow-torch furnace, it is evident that the temperature of the gases escaping through the air chequers is much lower than those escaping through the gas regenerators, as the incoming gas cannot possibly lower the temperature of the gas chequers below 1,050 to 1,100. Therefore, it is evident that by making all the gases escape through the air regenerators the temperature of the incoming air will be considerably higher than when the gases are divided, and the resultant temperature of the mixture of gas and air will be substantially the same as at present.

This construction appeals strongly to those to whom it has been suggested, because it eliminates the gas loss that now occurs whenever the furnace is reversed, when not only all the gas from the end of the port back through the generators to the gas valve is lost, but with most designs of valves the gas in the mains back to the producers is exhausted by being connected to the stack during reversals. It eliminates the hydrocarbon loss which now occurs in the regenerators and the difficulties due to the clogging of the gas chequers. This construction greatly decreases the volume of the slag pockets and the heat losses due to radiation from the excessive space between the chequers and the ports. Structurally this construction is exceedingly desirable, as it greatly decreases the cost of the furnace and shortens the distance required from centre to centre of furnace by 5 to 10 ft. It also eliminates the centre wall in the slag pockets and the need of overhung brickwork in the uptake.

The author concludes by expressing his opinion that the transition through which the open-hearth is now passing will so increase the capacity of existing units that there will be practically no construction of new open-hearth plants required to meet the demand for steel for a number of years, but that one of the biggest problems incident to the introduction of the rapidly operated furnace will be to get the raw material to the furnace and to handle the material on the casting side. While previous inventions in the open-hearth have had for their object increasing the comfort of the operators and the decreasing of the shut-downs and repairs to the furnace, he is of opinion that the effects of this invention are so far-reaching that it is difficult to appreciate the magnitude of the development. The principal advantages claimed are:—(1) Better steel; (2) increased fuel economy; (3) greatly increased output; (4) longer life of the furnace; (5) possibility of using a higher percentage of scrap; (6) decreased plant cost for a given capacity. By using unregenerated producer gas as proposed, it should be possible to obtain the following additional advantages:—(*a*) Additional fuel economies; (*b*) greatly decreased cost of construction; (*c*) simpler construction.

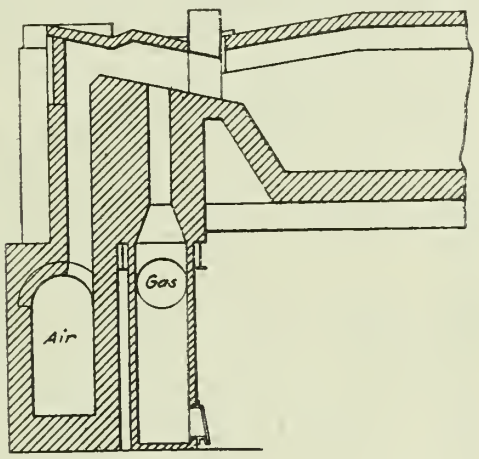


Fig. 2.—Section through Combined Port designed for Unregenerated Producer Gas.

The Institute of Metals.

The forthcoming Swansea meeting of the Institute of Metals will see the inauguration of a series of annual public lectures on subjects of practical interest for those engaged in the non-ferrous metals industry. The lectures are additional to the annual May lectures of the Institute, which have constituted a notable feature of their work since 1910.

Dr. R. S. Hutton, a Member of Council of the Institute, and Director of the British Non-Ferrous Metals Research Association, is to deliver the first of these lectures, his subject being "The Science of Human Effort (Motion Study and Vocational Training)." The lecture will be given at 8 p.m. on Tuesday, September 19, at the Y.M.C.A., Swansea. Tickets can be obtained from Mr. G. Shaw Scott, 36, Victoria Street, London, S.W.1.

Trade Talk.

Instructions have been received in Belfast to begin the building of an Atlantic transport liner of 17,000 tons, and to resume work on two large oil tankers.

The report, published in the Press last week, that Messrs. Armstrong Whitworth had received a large Government contract has been contradicted by the Admiralty.

Mr. D. McLain will lecture on "Semi Steel and Cupola Practice," before the Newcastle and District Branch of the Institution of British Foundrymen, on September 2.

A contract has been received by the Westinghouse Brake & Saxby Signal Company, Limited, to provide the signalling material for 120 miles of alternating current signalling for the New Zealand Government Railways.

The "Natalina," a large steamer, built at the Furness Shipbuilding Yard, Haverton Hill, for Furness Withy's American trade, has arrived at Hartlepool, where she is to be fitted with geared turbines of 5,000 shaft horse-power, built by Richardsons, Westgarth & Company.

At a recent meeting the Organisation and Management Committee agreed that the support of the F.B.I. should be given to the request of the Trade Marks, Patents and Designs Federation for co-operation in urging the adherence of the United Kingdom to the Madrid Arrangement for the International Registration of Trade Marks.

Engineer Vice-Admiral Sir George Goodwin, K.C.B., late Engineer-in-Chief of the Fleet, and Dr. James Colquhoun Irvine, C.B.E., F.R.S., Vice-Chancellor and Principal of St. Andrews University, have been appointed to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

The washery at the Senghenydd pit owned by the Lewis Merthyr Consolidated Collieries, Limited, in South Wales, is being remodelled by Messrs. Head, Wrightson & Company, Limited, of Stockton-on-Tees. They are installing their well-known "Nota Nos" coal washers, also their fine-dust extraction plants for a capacity of 70 to 80 tons per hour.

No less than 30,000 names are registered for the evening classes provided by the Glamorgan Education Committee. Of these, about 500 are annually eligible for the summer mining courses at the University College, Cardiff, and the Penarth County School. The subjects treated include electrical engineering, mechanical engineering, economics, physics and chemistry.

Branches of the Boilermakers' Society have been advised to take a vote of their members during next month as to whether the organisation shall any longer continue affiliation with the Engineering and Shipbuilding Trades' Federation. The society's executive, while facilitating the ballot, points out that already big modifications in the constitution of the federated trades are imminent, and it is itself not desirous of seeing the society pursue a policy of isolation.

Recently the New Zealand Government placed with Messrs. Vickers, Limited, orders for two Pelton turbines, which are now being erected on site, and two Francis turbines, each of 3,100 h.p., for the Hora Hora Power Station on the Waikato River, these machines, operating under a 27 ft. head. This firm recently obtained the orders for the 6,000 k.v.a. generators, and the 100,000 volt. switchgear for the Mangahao Hydro Electric Power Station in New Zealand.

A contract for 12 four-wheeled coupled bogie express passenger locomotives for the Caledonian Railway has recently been awarded to the North British Locomotive Company, Limited, of Glasgow, whilst the Vulcan Foundry, Limited, of Newton-le-Willows, Lancashire, have an order for fifteen 4-8-0 metre-gauge tender engines for the Uganda Railways. All of the locomotives are to be fitted with the patent superheater invented by Mr. J. G. Robinson, the chief mechanical engineer, Great Western Railway.

Traders and representatives of Scottish Chambers of Commerce have asked that there shall be a decrease of 12½ per cent. on the present ordinary and exceptional transit rates. It was urged that Scottish traders should not be asked to accept less than what had been granted by the English railway companies. Railway companies, who had a direct monopoly, ought to help in every possible way in the attempt to improve trade. It was quite understood that, as commercial concerns, they should be run so as to give a return on the capital of their shareholders, but at present the situation was so serious that every possible endeavour should be made to meet Scottish traders in the way that the English companies had met English traders.

Mr. George F. Mason, the chairman of the Bristol Channel District of the Society of Consulting Marine Engineers and Ship Surveyors, presided at the general meeting of the members of the district held at the Park Hotel, Cardiff, on Thursday, August 17. He was supported by Mr. George Humphreys (President of the society), Mr. C. E. Smith, Hartlepool (Vice-President), Mr. Hy. Grey, London; Mr. John White Boyd, Glasgow; Mr. George Strong, Hull; Mr. C. M. Burls, Mr. Casebourne, and Mr. H. E. J. Camps, London; and the general secretary (Mr. R. K. Munroe). The chairman extended a welcome to the President and other members of the council, after which a Paper was read by Mr. E. J. Scott, associate member, of London, on "The Inflow of Water through Ballast and Bilge Pump Lines," followed by an interesting discussion.

A notice is being issued to the unsecured creditors of Fuller's United Electric Works, Limited, to the effect that consequent upon the trade depression it is necessary to take steps to reorganise the capital. The company has consulted Sir Arthur Whinney, who is engaged on a scheme which will be submitted to a meeting to be held at the earliest possible date. In 1920 the company made an issue of 200,000 7 per cent. notes in order to provide additional working capital. These notes do not mature until 1925. It is hoped that the business will be kept going until the scheme has matured, and to this end the directors are refraining from paying such sums as are due to unsecured creditors so as to prevent anyone obtaining a preference. In the meantime the business is being carried on in order to preserve the goodwill, any necessary supplies being paid for in cash.

It is understood that the London Electric Railway Company have decided to place contracts with five of the principal British railway rolling stock manufacturers for the design and building of a sample electric passenger coach of all steel construction and embodying all the latest improvements, including fire resisting and safety appliances, for experimental service on the Baker Street and Waterloo, the Great Northern, Piccadilly and Brompton, and the Charing Cross, Euston and Hampstead Tube Railways. The successful firms are the Metropolitan Carriage, Wagon, and Finance Company, Limited, of Saltley, Birmingham, the Gloucester Railway Carriage and Wagon Company, Limited, the Leeds Forge Company, Limited, the Birmingham Railway Carriage and Wagon Company, Limited, and Cammell, Laird and Company, Limited, of Nottingham.

The Industrial Court has issued its award in an arbitration between the Workers' Union and Messrs. Guest, Keen, & Nettlefolds, Limited, Dowlais, with reference to the claim of the union to reinstate a quarter of a turn per shift previously paid to their members employed at the ingot-mould foundry, Dowlais Works. The quarter turn per shift in dispute has been paid in the ingot-mould foundry for many years. Wages have been based on a nominal day rate, but the worker has, in fact, been paid this nominal rate plus one quarter, and such percentage addition as was payable under the steel-workers' sliding-scale has been calculated on this enhanced base. The Dowlais works closed down owing to lack of orders in January, 1921. When work was resumed in January, 1922, the employers, it was stated, without notification to the union, ceased to pay the extra quarter turn, and it was against their action that the union appealed. The Court decided that the quarter turn should be reinstated for a period of four weeks from the beginning of the first pay period following this decision; and that as from the termination of such four weeks there should be paid such rate as might be agreed by the parties. Should the parties be unable to agree the matter should revert to the Court, who, on the application of either party, would be prepared to receive additional evidence and give a further decision.

Company News.

Charles Clifford & Son, Limited.—Dividend, 10 per cent. on ordinary, tax free.

John Oakey & Sons, Limited.—Interim dividend 2½ per cent. on ordinary, less tax.

Fairbairn Lawson Combe Barbour, Limited.—Interim dividend of 5 per cent. on preference shares; 8 per cent. on ordinary.

Humber Graving Dock and Engineering Company, Limited.—Final dividend of 4 per cent. on ordinary, making 4 per cent. for year.

Walter Scott, Limited.—Profit, including £10,826 brought forward, £24,256; interest on 4 per cent. debenture stock, £12,000; amount carried to special reserve account, £7,531; carried forward, £2,225.

Compagnie des Minerais de Fer Magnetiques de Mokta-el-Hadid.—This concern reports that the deliveries during the first half of the current financial year have already reached 203,000 tons, as against 225,250 tons for the whole financial year 1921.

IRON AND STEEL MARKETS.

Pig-iron.

The close of the holiday month has brought little change in the general position as far as pig-iron is concerned, but it is, at all events, reassuring to note that movements on the whole are favourable to a steady expansion of business on account of home consumers as the autumn advances. This view is confirmed by conditions reported in the Midlands, where pig-iron markets presented a very firm appearance. To a large extent this may be attributable to the American coal strike, exports of fuel to that country having combined to strengthen the market for coke. Naturally, in face of such a development, pig-iron quotations were firm, though not as yet quotably higher. There were also reports of increased business, which, here and there, has enabled smelters to obtain a little accumulation of orders, though there is still nothing like good forward contracting. The interruption of the Race Week holiday on Teeside was doubtless responsible for the uiet conditions prevailing in the Cleveland iron market, but there are anticipations of increased activity this month when the autumn buying usually begins. On the export side the one bright spot is the American demand, there having been further sales last week both of hematite and foundry iron, and it is reported that there is an inquiry also for forge iron of a special quality. This trade comes at an opportune moment in view of the slackness in other directions, and conviction is strong that whether they can afford it or not Cleveland makers will have to further cut prices to get their share of prospective business. It is now possible to land Continental iron into Scotland at about 85s. per ton c.i.f., whilst No. 3 Cleveland iron costs 93s. per ton at Grangemouth. Moreover, Midland iron is offered at 80s. per ton f.o.t. at works, and is being shipped at East Coast ports well below the price of Cleveland iron. Thus Cleveland makers are being shut out of many markets, and the only remedy seems to be lower prices. No further move, however, has yet been taken in that direction, and No. 3 G.M.B., the standard quality, is not less than 87s. per ton, some makers quoting 87s 6d. The scarcity of No. 1 and silicious iron keeps the price at 95s. per ton, but No. 4 foundry iron is down to 86s., No. 4 forge 84s., and mottled and white 80s. per ton, f.o.t. or f.o.b.

In the North-East hematite markets there has been a little more iron sold for shipment to the States, and a steady trade is being done with South Wales steel makers, who find this quality the cheapest in the country, even with transport charges added. Very small parcels are being sold to Italy, and occasionally an inquiry comes to hand from Belgium. Steel makers have big stocks and would gladly realise. They cannot, however, cut prices further, and if they did so it is doubtful if the demand would much increase. Under these circumstances 89s. per ton represents about the minimum figure for mixed numbers, and some makers will not quote below 90s. per ton with No. 1 at a premium of 6d. per ton.

Some recovery in the ferro-alloy market may be noted of late, ferro-silicon in all grades, from 10 to 12 per cent. to 90 per cent., having received attention, but with 45 per cent. material mostly in request. Prices are very steady, and the previous easing-off in 45 per cent. grade appears to have been checked. Seventy-five per cent. is, however, easy in price at £21 15s. to £22 delivered, and it is possible a better figure could be secured with a firm offer for a fair-sized parcel. Twenty to 25 per cent. grade is quoted round about £9 per ton delivered c.i.f. United Kingdom port, to which another 20s. should be added to cover railway carriage, etc., to inland destinations. Ferro-manganese and spiegel are unaltered in price, and the general situation remains unchanged, with perhaps a little easing off in American demand, due to the coal dispute there and consequent restricted operations.

Finished Iron.

Indications in the principal markets for finished material are certainly favourable to a much improved tendency, and although full employment at works is by no means completely restored, the increasing volume of inquiries and new business actually transacted inspires the hope that the depression is gradually disappearing. So far, inquiries in circulation have related to comparatively small tonnages, but in the aggregate represent a fairly substantial total, affording reasonable grounds for encouragement. At Birmingham last week there was a much more optimistic tone apparent, and manufacturers generally agreed that though orders on a large scale were scarce, business on the whole was distinctly better. Marked bar makers are steadily employed, but would certainly welcome an expansion of demand for forward account, the orders now in hand representing only a moderate tonnage. Unmarked iron is practically unchanged, inquiries for nut and bolt material having fallen off lately, while in contrast the market for gas strip shows a distinct improvement, even in competition with similar products of steel, mills for the manufacture of this material having been recently restarted in Birmingham. Iron founders in the Midlands and elsewhere supplying the engineering trade with castings are reported to be disappointed at the extremely slow expansion of business in that connection, and in most departments of the industry orders are difficult to obtain. Business in the foundry trade is also adversely affected by the wholesale suspension of many building schemes, due to the withdrawal of Government support.

Steel.

Conditions in most branches of the steel industry continue quietly active, Sheffield manufacturers reporting a steadily growing demand for most of the cheaper qualities, both for home and export. Continental makers are beginning to inquire again, but Germany, owing to exchange difficulties, appears to be no longer a factor in the competition for business. The bonus reductions recently accepted by the steel trade workers will enable British manufacturers to quote more advantageously for some of the important contracts now offering, and the effect on Sheffield industry will, it is expected, be substantial. Railway steel orders are being rather more freely placed, and tool-steel orders are being fairly well booked. The demand for semi-products is also on an improving scale, soft basic qualities being a leading feature. In this connection Lincolnshire makers are becoming somewhat keen competitors in the Sheffield market, and in consequence local makers have cut the price to £7 5s., but even so the Lincolnshire figure is not reached. Medium basic billets cost in the region of £8s 5s., and hard basic £8 10s. to £8 15s. In acid billets there is not quite so much doing, but prices hold at the old figures, viz., £10 for Siemens and £12 10s. for Bessemer. At Glasgow, steel-sheet makers remain fairly busy. The recent reductions in home prices have stimulated a fair tonnage of orders, and this, with the demand for export, has made makers' position much better all round. Export business continues to improve. The demand from the Colonies is still good, and certain other oversea markets are again becoming interested in British material.

There is little fresh to report in the condition of the tinplate market, the depreciation in the exchanges having apparently checked Continental buying for the time being. There is more inquiry coming from the Far East, but no business of any moment has yet resulted. South America has been placing a few orders, but quantities were not large. Prices of the leading lines may be quoted as follow:—Coke Tins.—IC 14 x 20, 12 sheets, 108 lbs., 19s. 3d. to 19s. 6d. per box; IC 28 x 20, 112 sheets, 216 lbs., 38s. 6d. to 39s. 3d. per box, all net, f.o.b. Wales.

Scrap.

In most markets for scrap metal some slight improvement may be reported, but progress in this direction is necessarily slow, and the majority of merchants now hold stores greatly in excess of the present competitive demand. In Yorkshire there is a better inquiry for steel scrap than for some time past, but users seem unwilling to pay the prices asked by holders, who contend, quite truly, that their quotations are low as compared with new material. It is stated that German representatives are in the market again for melting scrap. As more furnaces are put into operation, and competition for the available supplies of scrap becomes greater, there is little doubt that the expectation of holders that prices will rise will be fulfilled. Heavy steel in furnace sizes is quoted at about 67s. 6d., and heavy steel turnings of good quality at 58s. to 60s. There is only a poor demand for iron scrap. A little wrought material is being sold. Machinery scrap of good quality for foundry purposes is quoted at 75s. to 80s., but the market is very quiet.

Metals.

Copper.—The market for standard copper during the past week has developed a weaker tendency, due, in part, to nervousness arising from the political situation and the erratic disposition of foreign exchanges. There has been, further, a lack of confidence in buying on consumptive account, and an absence of the

speculative dealings which of late have been an active feature in metal markets. On the other hand, however, the partial settlement of the coal strike in America has tended to balance matters. Reports from that country state that the position is comparatively firm, with sellers disinclined to offer at below 14 cents. The statistical position in the United States has improved, stocks now being at a normal level, and it is anticipated that with a settlement of the railway strike a good demand from American consumers will be forthcoming. Current quotations:—*Cash*: Wednesday, £63 2s. 6d.; Thursday, £62 7s. 6d.; Friday, £61 12s. 6d.; Monday, £62; Tuesday, £62 10s. *Three Months*: Wednesday, £63 2s. 6d.; Thursday, £62 10s.; Friday, £61 15s.; Monday, £62 5s.; Tuesday, £62 15s.

Tin.—Reports of a partial settlement of the American coal strike imparted a somewhat stronger tone to the market for standard tin last week, but otherwise the position is practically unchanged. The close of the holiday month, however, will, it is anticipated, bring a revival of more active conditions, advices received from the States suggesting a small resumption of buying in that quarter, while some improvement may also be expected in the Welsh tinplate demand, in view of the autumn canning season. At one time the East showed considerable reserve, and did not make any appreciable sales, but recently a fair amount of business was done out there. Taking a general view of the market, a note of caution seems necessary, as in view of the large "option" account which exists, price movements in the near future may be influenced less by actual developments in the situation than by artificial factors and the mood of operators. Current quotations:—*Cash*: Wednesday, £160; Thursday, £158 15s.; Friday, £157 10s.; Monday, £158 7s. 6d.; Tuesday, £159 10s. *Three Months*: Wednesday, £160 2s. 6d.; Thursday, £158 17s. 6d.; Friday, 157 12s. 6d.; Monday, £158 10s.; Tuesday, £159 15s.

Spelter.—Messrs. Rudolf Wolff & Company, in their weekly report, state:—Much of the recent decline has been recovered. More interest has been taken in forward delivery, for which a good speculative demand has arisen. The near position, though comparatively neglected, is still well controlled, and the backwardation has been fairly constant at about £1. The position otherwise remains about the same; markets in the U.S.A. and on the Continent are firm, and producers maintain the same independent attitude. Remelted spelter is not being offered so freely, and the price has advanced, while hard spelter is quiet, but stocks are strongly held, and full prices are asked. Current quotations:—*Ordinary*: Wednesday, £31 10s.; Thursday, £31; Friday, £30 7s. 6d.; Monday, £30 15s.; Tuesday, £31.

Lead.—The market for soft foreign pig was subject to slight fluctuations in values during the past week, but with little material change in the general conditions. The consumptive demand has recently seen some improvement, and sales have been fairly well absorbed, although rather heavier deliveries have caused a certain amount of liquidation. Current quotations:—*Soft foreign* (prompt), Wednesday, £24 17s. 6d.; Thursday, £24 10s.; Friday, £23 15s.; Monday, £24; Tuesday, £24 7s. 6d.

Personal.

The late Mr. Frederick John Gardner, of Durleston Lodge, St. Agnes Road, Moseley, Birmingham, manufacturer, left £21,483.

The late Mr. Martin Henry Watts, of Oxford Road, Macclesfield, of the Catherine Street Foundry, Macclesfield, left £5,496.

The late Mr. John Nathaniel Harrison, of Chatham Street, Liverpool, engineer, a member of the firm of Hosking & Callan, left £1,944.

The late Mr. Nicholas Trestrail, of Claremont Road, Redruth, Cornwall, of the firm of N. Trestrail & Son, engineers, Redruth, left £5,780.

The late Mr. Norman Joseph Lockyer, of Darlington, manager of the North-Eastern Railway Company's locomotive works at Darlington, left £5,806.

Mr. Howell Jones, general manager of the Dowlais undertakings of Messrs. Guest, Keen & Nettlefolds, Limited, has been made a Justice of the Peace for Merthyr.

The late Mr. Richard Wilder, of Erleigh Grange, Erleigh Road, Reading, senior partner of John Wilder, of the Yield Hall Foundry, Reading, and of R. J. & H. Wilder, implement makers, Wallingford, left £18,014.

Mr. W. J. Holloway, who has entered upon his retirement after 42 years' service at the Bute Docks, entertained his clerical staff, past and present, of the Great Western Railway (Cardiff Railway section) at dinner at the Queen's Hotel, Cardiff, on August 19.

Deaths.

Sir John Bryn Edwards, Bart., died at his residence, Hendrefoilan, Swansea, on Tuesday, August 22. Sir John, who was the first baronet, had been in failing health for a couple of years, but his illness only took a serious turn on Friday last. Sir John Bryn Edwards was the eldest son of the late Mr. W. H. Edwards, J.P., proprietor of the Duffryn Steel and Tinplate Works, Morriston, and grandson of the late Mr. Daniel Edwards, their founder. Sir John's father developed these works and made a success of them, and he did a good deal of public work at Swansea, where he was a member of the council for many years, became an alderman, and passed the mayoral chair in 1894. Sir John's mother was a daughter of the late Mr. William Williams, J.P., of Maestygwernen, owner of the Upper Forest and Worcester Steel and Tinplate Works, Morriston, and sister of the late Mr. T. Jeremiah Williams, M.P., of Maesygwernen, so that he was intimately connected with the chief industries of the district by descent on both sides. Sir John received a classical and technical education, and graduated M.A. at Cambridge. His younger brother lost his life in the war, and he himself soon after commencing his business career became a victim to incipient pulmonary disease, which afterwards prevented the development of his prospects in the business life of South Wales. He was, however, of an active and sanguine nature, and, endeavouring to follow in the footsteps of his father, he entered public life as a member of the Swansea Council in 1918, and would have been due to retire after his first term of office next November. He showed a great interest in the technical business of the corporation, but his activities were circumscribed by his failing health. The early death of his father left him in possession and control of the Duffryn Works, and these he soon afterwards disposed of to the company which now carries them on.

The partnership heretofore subsisting between Arthur Main and Charles William Frederick Temple, carrying on business as engineers and contractors, at Adelphi Chambers, Shakespeare Street, Newcastle-on-Tyne, under the style or firm of Main & Company and Main & Temple, has been dissolved.

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THE

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Contents.

	PAGE
De Reaumur (1683-1757)	191
Steam Turbine Parts	192
An Apprenticeship Course in Foundry Practice.—VIII.	195
Use of Explosives in Foundries	198
The Jenkins Air Gun	198
Production of Steel Castings	199
Sulphur from Blast-Furnace Slag	202
Correspondence	202
Company News	203
Personal	203
Contracts Open	203
Gazette	203
Trade Talk	204
Iron and Steel Markets	206

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De Reaumur (1683-1757).

Many factors render some notes on the life and work of the great French savant De Reaumur, particularly *apropos* this year. In the first place, it is the bicentenary of the publication of his work on "L'art de convertir le Forgé en acier et L'art d'Adoncir le Fer Fondu," or, roughly translated, the art of converting iron into steel and softening cast iron. In the second place, there is a renaissance in the malleable castings industry, of which he was the originator. The third reason is that at least some British foundrymen will go to Paris next September, and no doubt they will have an opportunity of inspecting a copy of his book. This, by the way, has already been handled by some of the members of the Institution of British Foundrymen, through the courtesy of Mons. Ramas, the President of the Association Technique de Fonderie (France), who brought a copy with him on the occasion of the Birmingham Conference.

The current issue or "La Revue de Métallurgie" contains a short biography by Mons. Leon Guillet, and a *resumé* of his epoch-making book by Mons. J. Cournot.

Réne-Antoine Ferchault, Esquire, Lord of the Manors of Reaumur, Angles and Bermondière, Commander of the Royal and Military Order of Saint Louis and of the Royal Academy of Arts of Rochelle, Member of the British, Prussian, and Russian academies of science and of the Institute de Bologna, was born at La Rochelle in 1683. After primary education in his home town, he went to the Jesuit College at Poitiers, and leaving there in 1699, he studied the law at Bourges. In 1703, attracted by mathematics and physical sciences, he went to Paris, where he remained the rest of his life. At the age of 25 he published his first two theses on geometry.

If the whole of Reaumur's works are considered, one cannot help being amazed by the diversity of subjects studied, this bearing a singular comparison with those of Bessemer, but to Reaumur can be given the palm for being more scientific and methodical.

He studied successively the structure of various animals, the possibility of using spider webs as silk, showing that, contrary to recent research, they could not be used; the manner by which various marine bodies, mussels, star-fish, etc., attach themselves to solid bodies; he also discovered how certain fish lay eggs, which, when crushed, yield a yellow colour, becoming, after rapid exposure, a glorious purple, useful as a dye.

He proved that certain shell fish, when deprived of a limb, quickly grow another, and set forth the exact circumstances surrounding this reproduction. Another study was the conservation of eggs by coating with substances capable of closing up the pores of the shell.

In 1734 to 1736 various books on insects were published dealing successively with caterpillars, butterflies, moths, flies and bees. His last communication to the Academy was on the subject of the manner in which birds build their nests.

Another subject which interested him was the force necessary to support a cord. He strove to find whether it was greater than the sum of the forces necessary to support its threads. He decided that it was less, and further stated that the less twisted the threads the stronger it should be. Lustre for imitation pearls, he showed, could be obtained from a material extracted from whitebait, and found that real pearls are derived from a disease in the oyster.

However, the name of Reaumur will not be remembered for the above studies, but for his invention of the process of making malleable iron castings.

Something of his public-spirited character is shown by the fact that when offered a pension of twelve thousand pounds he gave this to the Academy to form what was, perhaps, the first research fund ever opened. In the preface to his book Reaumur states that he has been reproached for not having kept his discoveries secret, and insists that it is his first duty to consider the general good of society.

Whilst the method of making cemented bar steel was known before his experiments, he explains that the process was kept secret, and he had to start with no material whatever to work upon. Finally, he evolved two satisfactory carburising mixtures, the first consisting of 2 parts of soot, 1 part of charcoal, 1 part of ashes, and a little less than three-quarters of a part of rock salt, and the other a similar mixture, but with 2 parts of ashes.

The researches on malleable we hope to detail in a future issue.

Reaumur died at the age of 75 whilst on a visit to Bermondière.

To-day metallurgical conditions are such that everything points to a distinct revival in the industry which this famous savant initiated.

Steam Turbine Parts.

By S. G. Smith.

Cast-Iron Diaphragms for Steam Turbines.

This class of work is restricted to the comparatively few engineering firms who manufacture impulse-type steam turbines. The diaphragms are usually made in cast iron with mild steel blades. They are usually split on the horizontal centre line with spigot and socket joints, being machined to prevent leakage from one side of the diaphragm to the other. In Fig. 1 B shows a diaphragm arranged for partial admission, C a diaphragm with full admission, whilst A depicts the half diaphragms in position in the top half of the turbine cylinder.

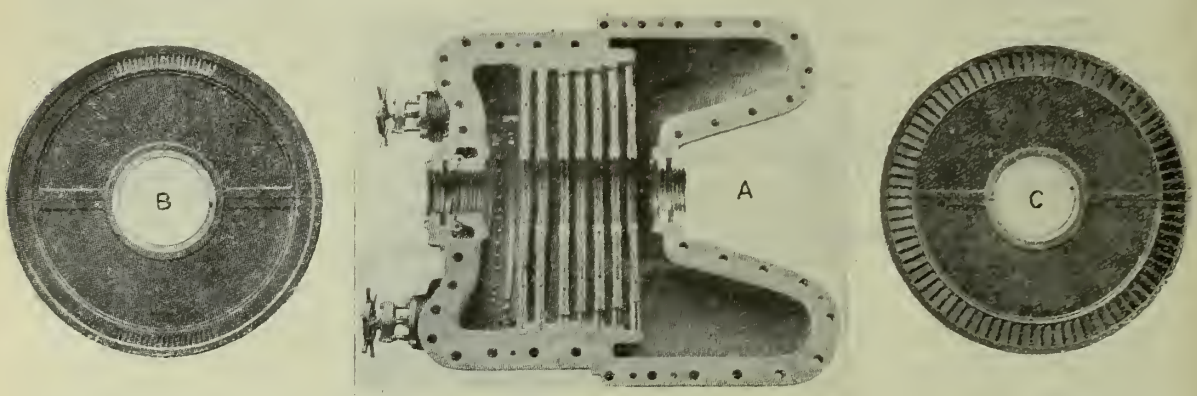


Fig. 1.—A Shows Diaphragm Box; B Arranged for Partial Admission, and C Full Admission.

In its passage through the earlier stages of a compound turbine the volume of steam is comparatively small, but as the pressure falls through the machine the volume increases considerably in the later stages. The mild steel blades which are cast into the diaphragms are suitably shaped to form nozzles in which the steam expands, and in expanding attains a velocity which is utilised on the rotating wheel which follows each diaphragm.

The sequence of operations throughout the various stages of the turbine is as follows:—The steam is first passed into a steam chest containing the governor and emergency valves which control the output and speed of the machine. It then passes to a series of nozzles, which are usually machined from mild steel and secured to the inside of the turbine casing. Steam expands in these nozzles, and the resultant velocity is utilised on the first rotating wheel. The steam by this time has been brought practically to rest again, and it is expanded in the nozzles fixed to the first diaphragm. In order that these nozzles may be of a reasonable height they are restricted to a small arc of the diaphragm. In expanding in the diaphragm nozzles the steam again increases in velocity, and the kinetic energy it thus acquires is utilised on the second rotating wheel. The steam having been brought to rest again on this wheel is again expanded in the next diaphragm, and so on until the exhaust stage is reached. After passing through the first or second diaphragm the pressure of the steam has been reduced considerably, and the volume correspondingly increased. It is therefore necessary to cast the nozzles into a larger arc in the second diaphragm than in the first, and in the third or fourth diaphragms steam will be probably admitted round the whole circumference of the diaphragms. As the steam continues to fall in pressure beyond this stage, and consequently increases in volume, the height of the nozzles cast into the diaphragm must be increased to allow a sufficient area for the passage of the steam. Fig. 2 shows a velocity wheel and nine Rateau wheels mounted on the spindle.

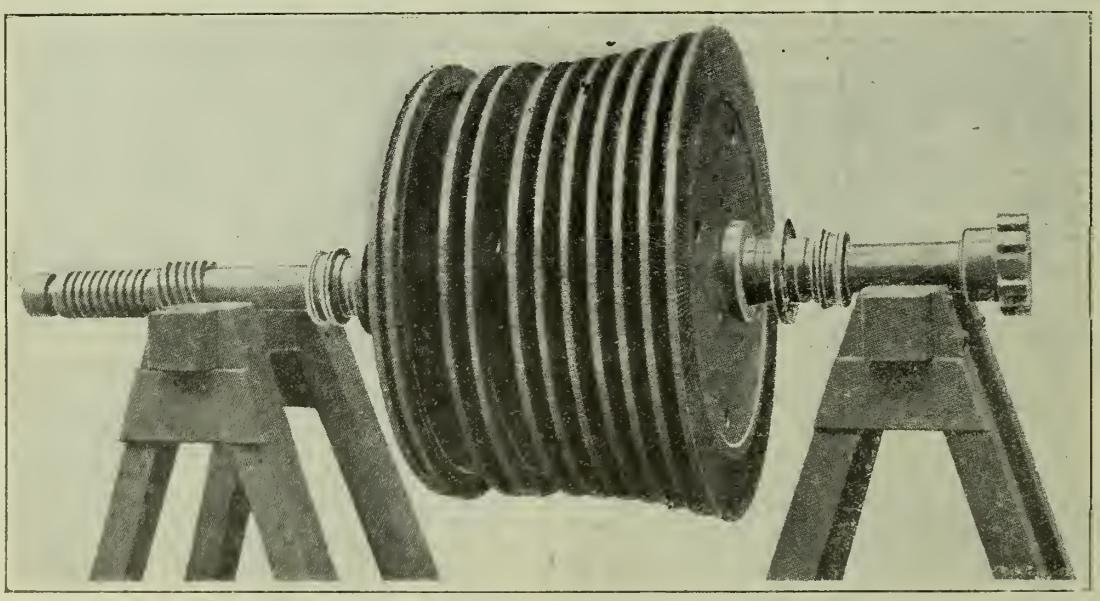


Fig. 2.—Velocity Wheel and Nine Rateau Wheels Mounted on a Spindle.

In Fig. 3 A is an enlarged section of the rim of this wheel, and B an enlarged section of the Rateau stages. This type of rotating wheel is usually employed for all except the first stage.

(Fig. 3) C shows a sectional arrangement of the high pressure nozzles and velocity wheel and three diaphragms and Rateau wheels.

Fig. 4 shows a complete half diaphragm suitable for one of the low pressure stages.

The diaphragms vary from 12 in. to about 9 ft. in diameter, depending upon the output of the machine, and in thickness from ¾ to 3 in., depending upon the pressure difference on each side of the diaphragm; for very high pressures or temperatures cast steel diaphragms are used. The number of diaphragms required per machine varies considerably with the steam pressure and temperature, vacuum or terminal pressure, and with the efficiency of the machine.

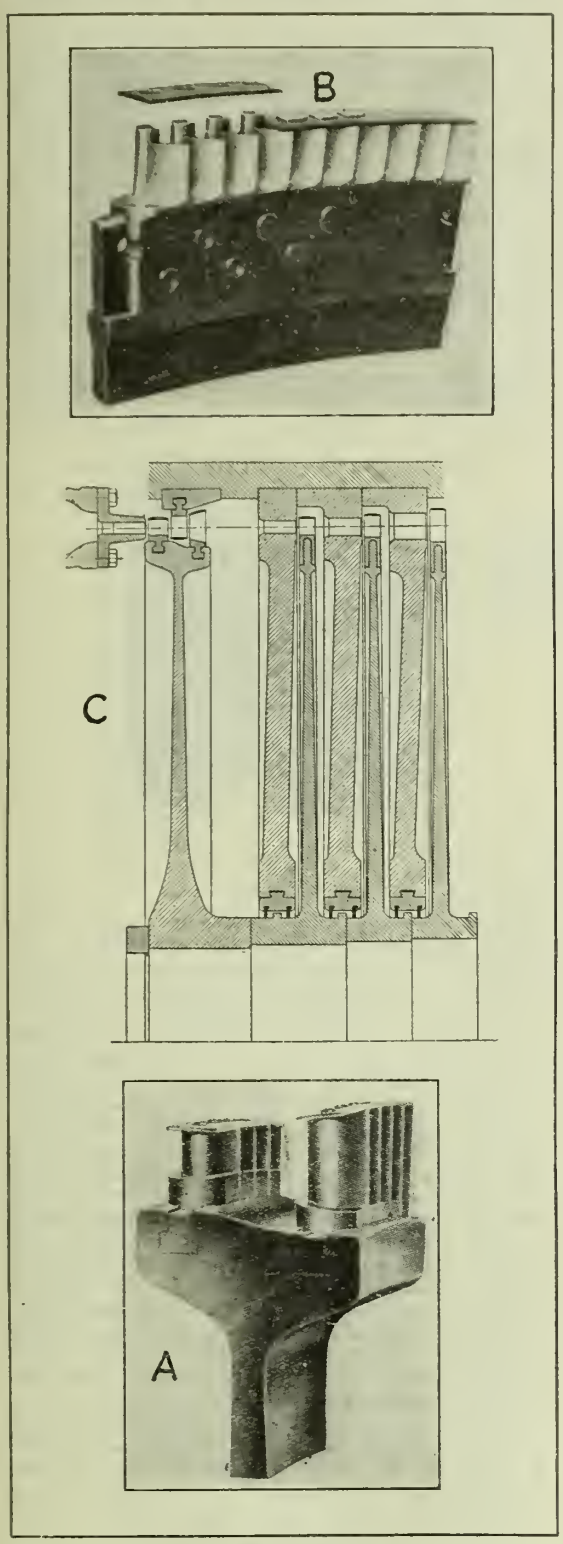


Fig. 3.—A is Section of the Wheel Rim; B a Section of the Rateau Stages, and C the Arrangement of the Diaphragm and Rateau Wheel.

Diaphragms may be either plain or dished and the height of the nozzles may be anything from ½ in, upwards. The weight varies, of course, with the diameter and thickness.

Method of Moulding.

Diaphragms, the supervision of which have come under the writer's supervision, have been made in green sand, dry sand, and loam. For those made in green sand the half patterns were fixed to follow-boards and moulded by semi-skilled men. Those made in dry sand were made from loose half-patterns by skilled moulders. The largest diaphragms were struck up in loam from strickles with an eccentric spindle, thus two large half diaphragms were swept up at one time, the eccentric race of the spindle allowing a dividing core, 6 in. wide, between the half diaphragms. This dividing core was formed by a loose making-up piece. So far as moulding is concerned, each of the above methods have reached a high standard of efficiency.

Core Making.

The cores which form the bladed parts or steamway passages, whether narrow or wide, are made in segments from core boxes. These cores are chiefly made by female labour, the exceptions being the very large cores, which are made by male coremakers, as they are too heavy for the former. The making of these cores call for the highest skill and care. It is an art-craft in itself, and efficiency in the operations can only be attained after long practice, with either men or women. It should be stated that the method adopted by some makers is by the use of a wheel machine. There are several makes of wheel machines that can be applied, and give great accuracy in setting the height and pitch of the blades. This process being continuous, it obviates joints and possible errors when making and assembling segment cores. But, apart from this aspect, cores made from a box are an advantage. The writer is not making this statement haphazard, as he realises quite well the general advantages of the wheel moulding machine, having had personal experience with them. He has arrived at this conclusion only after a full exchange of views with men who have used the wheel moulding machine for this purpose. When 50 to 60 half-diaphragms are made per week from small diameters up to 9 ft. diameter it would mean the employment of a large number of moulding machines; at the same time, efficiency and accuracy should not be sacrificed when deciding methods of moulding. With the segment cores most of the errors that can arise are under control.

Inspection.

The castings must be quite clean, both machined and unmachined surfaces. The metal must be dense and free from any areas of dross on all parts of the casting. To ascertain this, the castings are heavily hit with a steel-pointed hammer every 2 or 3 in. throughout the surface. If a casting is deformed in the slightest degree it is scrapped.

The least indication of fusion of the steel blades, any signs of looseness, or cold lap of the iron, small shot, etc., they are scrapped. The pitch and height of the blades must be accurate. A margin line is scribed around the inside and outside diameter of the port or steam passage; if this line deviates more than 1-32nd part of an inch the castings are rejected. Every blade, and every inch of the casting is minutely examined for possible defects. This is carried to such an extent that sometimes a magnifying glass is employed. These are the demands of the engineer respecting these castings. They are satisfied by the foundry; but this state of affairs has not been the work of a short period. It has been a matter of evolution during several years.

Runner Gates.

The runner gates must not impinge on the steel blades in the passage core. If this happens the blades will be fused. The gates must not beat against cores; that will cause a commotion with the molten iron, and possibly an accumulation of dross. The best position for the runner gates is underneath the cores, as the metal is then evenly distributed, and undoubtedly gives the most satisfactory results.

Pouring and Temperature Considerations.

The rate of pouring and temperature of the metal should, to some extent, be governed by the width of the port cores. If the port core be a very narrow one, say, from ½ in. to ¾ in. wide, the rate of pouring need not be so fast, or the temperature of the iron be so high, as when pouring a diaphragm with a very wide port.

In the case of the narrow-port diaphragms which have a fairly thick plate, say, 2 in., if the temperature is too high the ends of the blades projecting from the core will be liable to fuse, and the very narrow core may be penetrated by the very hot metal. In the wide port diaphragms, say, up to 24 in. wide, the grating must be ample, and the temperature of the iron high. If these two conditions are not complied with the result will be

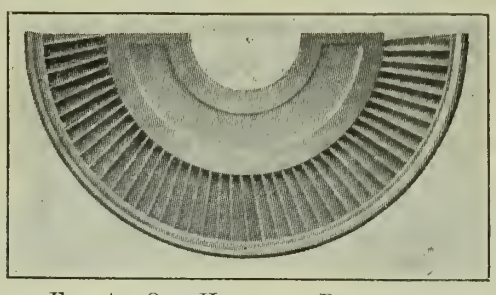


Fig. 4.—One Half of a Diaphragm.

in the narrow port diaphragm, fusion of blades and part fusion of narrow core. With the wide port diaphragm, cold-shut and cold-lap around the blades it is necessary to acquire a suitable temperature for pouring, the range may be in the region of 1,300 to 1,400 deg. C.

Analysis of Iron.

A suitable composition of iron is CC, 0.67; GrC, 2.95; Si, 1.42; Mn, 0.66; P, 0.50; and S, 0.09 per cent.

This analysis is representative of the iron used for these castings. It is capable of giving a high-temperature fluid iron. The half diaphragm castings are often tested for deflection, hence the iron must be strong and dense. A tensile test-bar from the above analysis showed 12.33 tons per sq. in., and the transverse bar 2,470 lbs. per sq. in., with a deflection of 0.075 in. and a Brinell hardness number of 229. All these tests are recorded daily.

Deflection.

It is imperative that no deflection in the plate or blades should occur under steam pressure owing to the small clearance allowed between the diaphragms and the movable wheels, which is necessary for the efficient running of the turbine, hence as a precautionary measure against this occurrence certain pairs of half diaphragms are tested for deflection, as shown in Fig. 5. One, two and three 9-in. rams are used respectively for certain

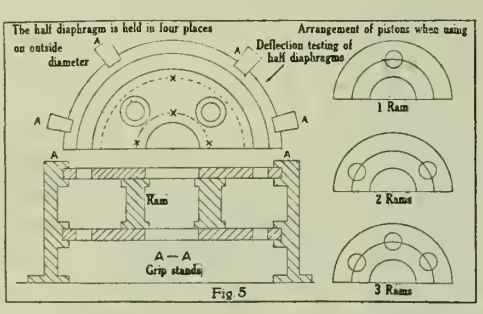


Fig. 5.

diaphragms. The pressure varies from 100 lbs. to 600 lbs. per sq. in., according to instructions received from the engineer's office. The micrometer measurements are taken from points indicated by small crosses before and after the pressure is applied.

Design of Steel Blades.

During the writer's experience with these castings several different types or design of blades have been used. Sometimes an altered type of blade brings in complications from a foundry standpoint. This aspect will not be enlarged upon, as such complications are always overcome. When it is considered that some blades are 24 in. long by 2½ in. deep, and that over 100 blades are cast in a diaphragm, some consideration is needed to escape possible evil effects.

Fig. 6 shows a reinforced diaphragm blade, which is now becoming general owing to its strength, which is derived from the loop. With this design special precaution has to be taken with short blades due to small air pockets in the loop.

Coating the Blades.

There is nothing better than a perfectly clean blade for the molten metal to rest against. But that is impracticable for several reasons, the chief reason being that the steel blade being continually in moist, or humid, atmosphere, very soon rusts. It is not intended to consider the composition of rust, but when molten iron comes into contact with it it is like putting a light to gunpowder. A gas is created, and gas holes are trapped and found in the casting.

An early experience may prove interesting. The cores containing the blades in some instances had been made months beforehand, consequently the blades were thick with rust, and in this condition they were being put into the moulds and poured, with the inevitable result that the castings, when machined, were full of shot and cavities, and, to the writer's amazement, surprise was expressed when the castings were returned.

The writer has occasionally ordered the cores to be broken up on this account, and instructed that all blades must be cleaned in future, also, when there is no coating on the blades, the cores should not be put into work until the the mould is on the way.

Sherardising is an excellent coating to protect the blades from rusting, and no doubt it also prolongs the good condition of the blades when in

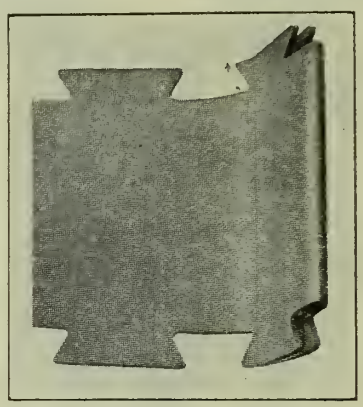


Fig. 6.—Reinforced Diaphragm Guide Plate.

work, minimising the penetration and pitting by the superheated steam; but zinc being incorporated in its composition the molten iron does not rest quietly against it. Probably a tin covering would meet the requirements, as it prevents rust forming, and the molten iron will not hold off it, providing the part of blade exposed to the iron is dry. Zinc volatilises below the temperature of molten iron, whilst tin fuses above the temperature of the hottest iron a cupola can melt.*

It is sometimes imagined that the molten iron that covers in the ends of the diaphragm blades should in some way unite with the steel blades. Such an idea is altogether wrong. If that occurred the end of the blade would be carbonised, and consequently become no longer steel, but a material equal to cast iron only. Even under the best conditions, when the molten iron tightens firmly around the ends of the blades, a slight carbonising takes place. Unfortunately, there is only a small margin between a loose or cold-lapped blade and a fused or partly fused blade.

The writer wishes to acknowledge the courtesy extended by the Publicity Department of the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, for permission to use the illustrations embodied in this article.

HYDROGEN GAS CYLINDERS. — Mr. Alex. E. Tucker, reporting on the explosion of hydrogen cylinders at the works of Messrs. J. W. Ellis & Company, of Newcastle, found in the cylinder, which he believed to have caused the explosion, 0.49 per cent. of copper. He based his belief partly on a microphotograph, which showed internal cracks and an entire absence of annealing. Mr. Tucker points out that the high copper content is characteristic of German steel. The full report is set out in the June issue of "Industrial Gases."

* [We cannot understand our contributor's statement, as tin melts at 232 deg. C.—Ed.]

An Apprenticeship Course in Foundry Practice.—VIII.

By Ben Shaw and James Edgar.

READING DRAWINGS AND SETTING DOWN WORK.

It may be as well to make it quite clear, at the beginning of this article, that it is not a disquisition on mechanical drawing. To attempt such would be to go quite beyond the scope of this series, although we shall, in a subsequent article, deal with geometrical drawing for both pattern-maker and moulder, including development of surfaces. The proficient patternmaker must be an efficient draughtsman, with a good knowledge of the principles of machine construction and design. This applies also to the moulder, but to a lesser degree, because machining allowances and modification in design are usually determined while the pattern is under construction. In addition to machine design, however, every patternmaker and foundryman should have a knowledge of what may be termed practical workshop drawing, including under this term the reading of drawings or blue prints, the making of workshop drawings, and dimensioned sketches. A knowledge of sketching is useful to the moulder when making grids, while he is greatly handicapped in setting cores before closing a mould if he cannot check work, either from the patternmaker's drawing-board or from the blue print. It is customary in many foundries for the patternmaker to stand by while a mould is being closed and test thicknesses as the mould is being assembled, but the moulder ought to be able to do this himself. The loam moulder must either be in constant consultation with the patternmaker or able to read drawings.

Setting out work is one of the most important tasks of the patternmaker. Many apprentices fall into the bad habit of simply copying a blue print with only the haziest notion of the design of the job until they have one or two views drawn. This method leads to many errors and much redrawing. It is also slower than getting a thorough grasp of the main features of the work at the commencement.

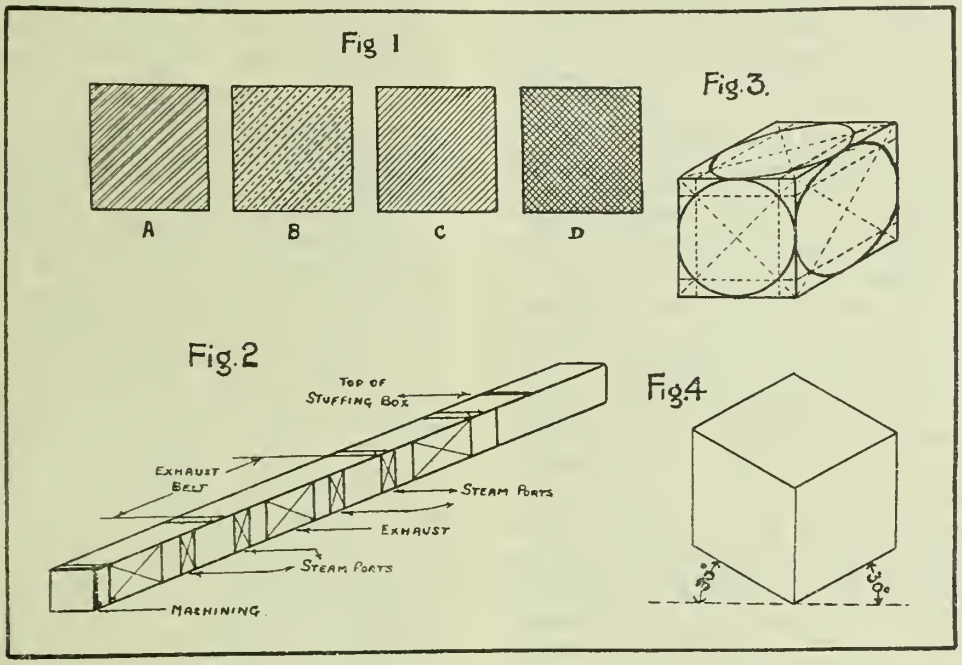
Mechanical Drawings.

A mechanical drawing may be defined as the principal means or language by which the inventor or designer conveys his requirements to the craftsman of the various shops. The number of views shown on a drawing or blue print depends to a large extent on whether the job is simple or intricate. If the shape is very irregular, or there is much coring, more views are necessary. A plan is a view looking on top of an object, while an inverted plan is a view looking on the bottom. Elevation may be described as front, rear, and side views, while sections are drawn to show coring or shapes that are not clearly indicated on outside views; it is supposed that the casting is cut through on a certain plane. Sections are invaluable for giving metal thicknesses. In addition to the main views, part views, sometimes called "scrap" views, are given of details, because, while a drawing to small scale may be convenient for the main parts of a job, a larger scale drawing may be necessary to show all the dimensions of an intricate part. The patternmaker must also follow out the practice when making his own working drawing, but, before we explain setting out methods in detail, we shall treat of the important subject of reading drawings.

Reading a Drawing.

The mental attitude of a moulder, when he receives a pattern and a drawing board in the foundry, should be similar to that of the patternmaker when he receives a blue print from the drawing office, hence much that is said here is of equal value to moulders and patternmakers.

It is not advisable, unless when work is very simple, for the patternmaker to prepare a drawing board until he has read the drawing carefully and is thus able to decide intelligently how many views it will be necessary for him to set out. It may be advisable, when dealing with a difficult job, to spend an hour or two in a preliminary comparison of views. It is wise to ignore dimensions until the general shape of the object is fixed in the mind, although it may be a help to memorise one or two of the overall sizes. There should be no consideration of construction methods at this point, all the attention being concentrated on the design. The highly skilled and experienced man may successfully determine construction while he is studying design, but the apprentice and the young journeyman will be well advised not to do so. When the general outline is clear and branches and main cores have been made out, it is advisable to study details, such as deviations from a regular outline, which may have a very important bearing on the construction of the pattern, bosses, facings, ribs, etc. Too much care cannot be taken at this stage, and each view should be examined closely, because draughtsmen are not infallible, and important details may be missed on two views and be shown on a third, and it is peculiar, but true, that if one fails to notice a boss during the first examination, then, by a defect in vision, it will probably not be seen during much subsequent



examination. Even clever craftsmen have often a difficulty of interpreting parts of a drawing, and find it necessary at times to project points from one view to another with rule, dividers, or straight-edge. The ability to visualise a pattern or casting is a great help, and skill in doing so should be assiduously cultivated.

The design of the job being thoroughly understood, it is necessary to look carefully at the various dimensions with a view to deciding how the pattern should be made. If an original drawing or tracing has been supplied, the brass, iron and steel parts can be separated by the section lining. A, B, C, and D in Fig. 1 represent the section lining for steel, brass, cast iron, and white metal respectively, but this method is gradually falling into disuse, the more reliable method being to have the material list printed on the drawing, and this practice is particularly desirable when blue prints are supplied.

The construction of the pattern and core-boxes cannot be definitely decided upon yet, but it is as well, before starting to set down the work, to form a general idea of the kind of pattern necessary, taking into consideration the number of castings required. Moulding difficulties have also to be considered.

A final examination of the drawing should be made before starting to set down in order to decide machining allowances, where slight modifications may be necessary—although this can be done when actually setting down the work—and also tool clearance. The latter is very important, and not always allowed for in the drawing office.

Setting Down Work.

A workshop drawing is not simply a copy of the draughtsman's drawing or an enlargement to full size. In setting out a valve chest, for instance, the cover, valve, valve seat, spring, if a spring-loaded valve, would all be left off, but the precaution of finally examining the setting-down in order to leave machining allowance is necessary. Then, also, some drawings are burdened with details which would only be confusing if placed on a workshop drawing at the beginning of a job, although it may be necessary to add them before the pattern is completed. In no cases should sizes be " scaled " from a blue print or from a tracing. When there is any doubt about a size, the draughtsman should be appealed to; so also when two views conflict.

Patterns are always set down full size and drawn larger than the dimensions given to allow for contraction, so that parts of the pattern or the whole pattern may be tried on top of the drawing or, if this is impossible, as when making large patterns on which many men are engaged, sizes may be transferred from the drawing board to the timber; and, if accurately made, the various parts will ultimately join together and give overall dimensions correct. The apprentice should set down every job, although it may not be necessary for experienced men to do so.

Drawing Boards.

There are several types of drawing boards in use in pattern shops. Plywood is occasionally used, and a neat drawing can be made on it, because there are no open joints, and it does not shrink or swell perceptibly. For large work boards in two parts hinged together are used in some shops, as they occupy less room when not in use. The most common type of drawing board is that made of 1-in. yellow pine boards jointed and battened. For small work some patternmakers still chalk boards in the old-fashioned way, but planed surfaces are much more satisfactory. The black painted board is unsurpassed for large work, because French chalk lines stand out distinctly.

The number of views that should be set out depends on the design of the work, the skill of the patternmaker, and whether several men will be employed on the job. In some cases a front elevation will be the only view required, and clever craftsmen who are able to visualise sections can dispense with much drawing. The man who sets out the drawing is in a favoured position, and not so much should be expected from others who may afterwards be transferred to help in the construction of the pattern, therefore additional sectional views and elevations will be necessary. It is always better to draw an additional view if a design is awkward.

The principles of setting out are the same for small as for large work; thus it is as difficult to set out, say, a carburettor as a large marine cylinder. Even greater accuracy is necessary for small work, because of thinness of the metal and the small areas, but if a mistake is made on a large drawing board it may be very costly to remedy the pattern if undiscovered until the final checking, before being sent to the foundry. The value of centre lines cannot be over-estimated. Some patternmakers use the gauge and try-square for laying down centre lines, while others describe a longitudinal line with a straight-edge, and draw all other lines geometrically from it. For small work the gauge and try-square are very convenient, while for large work, provided the edge of the board is quite straight and the try-square true, it is immaterial whichever method is adopted. If a design on both sides of a main centre line is the same, it may be advisable to draw a sectional view on one side. Some patternmakers draw several views on top of each other, a practice which may be necessary when dealing with very large work, but not generally advisable. In some cases work is set down on the patternshop floor and the drawing used for building on. It is very difficult to make a really accurate drawing on the floor, however, and the practice is only admissible for large work, such as ship construction patterns, the dimensions of which may be varied somewhat from the drawing.

The Length Rod.

A very important aid for setting down work are length rods, which are also invaluable for screwing up patterns that have been dissembled at the foundry, and also, on occasion, for testing cores in position. They are only used for what may be termed medium and large work. In most patternshops an assortment of length rods is kept in stock. For standard patterns the length rods are never destroyed, and it is customary not to deface a rod until the casting has passed the marking off table. Length rods are made from 1½ in. to 2½ in. sq., according to length, and dimensions are usually marked from one end, which, when testing heights, enables the patternmaker to rest the rod on the floor. For testing horizontal sizes it is often necessary, however, to mark the rod from a centre line, thus two faces might be 6 ft. from either side of a centre, and greater accuracy is secured by marking from a centre line than from an end. When a length rod has been selected, one side is reserved for heights, one for lengths, another for widths, and the fourth side may be used for boss and other centres that, to avoid confusion, have not been marked on any of the other sides. Lines should be marked across the rod with the scriber and a description printed. Rods should be varnished after they are marked off to protect the printed descriptions. Fig. 2 shows the height side of a length rod for a L.P. marine cylinder.

Although length rods are in use in all patternshops where large work is constructed, the method of making them differs. In some cases they are marked from the drawing board, but we prefer the method of making the length rod before a single line is set down on the board and transferring centres from the rod to the board. This is the most scientific way, and the length rod is a measuring instrument until the mould is closed in the foundry.

Should pattern construction lines be shown on a workshop board? In some cases it may be necessary to do so, but they should be as few as possible, and they should not be chalked or pencilled in, as this may lead to confusion and mistakes. It is much better if construction lines are wanted to make another setting-down of the part required on a separate board.

Strickles.

When making sweeping boards, etc., for loam moulding, a drawing board is invariably unnecessary, as each sweep made is really a drawing board, and the moulder has not much difficulty, as a rule, in understanding the various sweeping boards. When the loam mould has to be built, with ribs, bosses, and branches set in, it is advisable to draw an elevation—or plan—on one of the boards to which the moulder can refer. This need

not be a full-sized drawing, as it is only used to indicate the position of minor details.

Colouring Working Drawings.

All workshop drawings should be coloured in some way to make the various views stand out clearly. Even when the views do not overlap it is advisable, but when varying sections are drawn over each other it is essential if mistakes are to be avoided. When the drawing is not to be sent to the foundry section lines may be roughly sketched in with coloured chalks, varying the colour for each section, but when it is essential that they be sent to the foundry with the pattern it is better practice to varnish the various sections, using colouring pigments with the varnish to make the views distinct. Not only sectional lines, but lines determining plan or elevation, should be carefully coloured corresponding to the view they represent, and, in many cases, dotted lines can be introduced for important parts or metal thickness not shown in section. In every case the machining allowance should be distinct in colour from its corresponding section; this is useful as a check to the patternmaker, and it is valuable to the moulder. There is less time wasted in searching for lines when the drawing is varnished, and it is worth while preparing a good drawing, especially if many men will be engaged in the construction of the pattern, in order that the possibilities for errors may be reduced. The sections drawn upon loam boards must be painted or varnished to be of any value to the moulder.

Old Patterns and Castings as Guides.

A word may be said here about examining old patterns and castings with a view to discovering former practice. Some apprentice patternmakers cultivate the bad habit of going to the pattern stores and carefully copying the methods adopted in making similar patterns previously. This is a banal practice which kills initiative, and when faced with something for which a model is not available, the apprentice cannot decide what to do. It is almost as bad for him as the practice of some foremen explaining every detail of construction and moulding to prevent loss of time. Much can be learnt from the careful examination of old patterns, both of what is wrong as well as what is right. It is slavish imitation that is wrong. Even a highly skilled craftsman may learn much from comparison of his own work with the work of others. It is also useful after one has decided on the construction to examine a similar pattern. On large work it occasionally happens that modifications have to be effected to facilitate moulding after a pattern is complete or even in the foundry, owing to difficulties presenting themselves that were not anticipated, and an examination of an old pattern may reveal such alterations.

With regard to construction, a good deal can be learnt from an inspection of castings. The perfect casting could show no indications of mould joints, but such perfect castings are seldom seen. It is nearly always possible to trace joints, and if there is no opportunity of watching a pattern being moulded the casting can be seen when it comes from the foundry. The patternmaker who previously visualised the moulding operation can thus compare his ideas with the moulder's work. He has to bear in mind, of course, the possibility that another moulder might adopt different methods. The young moulder can also learn much from closely inspecting castings whenever he has the opportunity, although he is in a similar position to the young patternmaker who goes to the pattern store; he should form a general idea before examining the casting for joints. One of the most valuable habits that the apprentice can form is to keep a commonplace book and enter in it particulars of any new type of job. It need not occupy much time to make two or three freehand sketches and a brief description, with the time taken for construction and the timber used. The value of this is not merely that a book of reference is obtained, but writing down such particulars impresses them in one's mind. A keen observer sees many little "gadgets" and devices in the course of a week that are worth noting. An apprentice should never allow an opportunity to pass of examining work that has been executed by men who are recognised as being above the average in skill, because such men do not confine themselves to stereotyped methods.

Sketching.

Very early in his career the young patternmaker finds it necessary to make sketches. Not many moulders make sketches, nevertheless the ability to sketch is of use to them, and those who have the ability find sketches a great help to them.

Mechanical drawing is called orthographic projection, and sketching may be in the form of orthographic projection, or a pictorial representation by means of oblique or isometric projection. A sketch may be defined as the drawing of an object exactly as we see it. The patternmaker has almost continual need for sketching, and especially so in repair shops, in ship work, and in textile mill work. We have known many cases where a sketch by a foreman has conveyed his ideas to the workmen far better than a long explanation. It is a common occurrence for a patternmaker to be sent to a ship, a mill, or elsewhere, to get particulars for the construction of a new pulley, a bracket or a pipe. Sometimes a whole line of pipes is required, and the patternmaker has to make sketches and determine metal and flange thicknesses, taking into consideration steam pressure, etc. There are also occasions when a new pattern has to be modelled on a casting, which is some distance from the pattern shop, and it may be necessary to make several sketches before setting the work out properly.

No hard and fast rule can be made as to when orthographic projection and when pictorial representation should be used; when getting particulars for a pipe line it may be necessary to make one or two views orthographically projected of each pipe, but, it may also be of great assistance afterwards to draw a pictorial view of the whole pipe line showing joinings. A pictorial view does not lend itself to dimensioning very well. It is sometimes helpful, when making an elevation and plan of the required casting, to make a pictorial view of the place where the casting is to be fitted. The peculiar value of pictorial representation is that it conveys a fuller conception of what is required than several rectangular views, and if, as is the custom in some pattern-shops, one man does all the outside work, and the actual construction of the pattern is done by others, it makes the occurrence of mistakes less likely.

The apprentice should practice sketching on squared paper, although in the pattern-shop odd pieces of timber have to be used, and in the foundry the moulder, when he wants to make a sketch, uses the outside of a core-box or a discarded drawing board.

Drawing a Cube.

On all sketches from which a workshop drawing will have to be made the dimensions should be carefully marked, and where there is no room for dimensions, indicating letters A, B, C, etc., should be used and the equivalents written underneath thus: A—1½ in., B—7 in., C—4¾ in.

Fig. 3 is an oblique projection of a cube, and it will be observed that one face is shown in its true shape and correct dimensions which is very helpful for many purposes. In our previous article "Notes on Patternmakers Tools," the ordinary bench gauge and also the panel gauge were drawn in oblique projection, while the thin circle gauge, the bench tool rack, etc., were in isometric. To return to the cube, lines parallel to the line of vision, which would be shown in a rectangular elevation as a joint, are shown in an oblique projection by a full length line running at an angle to the horizontal. The angle is called the angle of "tilt," and is determined by consideration of which side it is most important to show up, thus a big angle would show the top to better advantage than the side, while a low angle would be more suitable if details on the side had to be shown clearly. Planes at right angles to the line of vision retain their true dimensions in the pictorial view, while it is better to make those lines parallel to the line of vision less than full size, to give a better conception of the proportions. In Fig. 3 circles are drawn on each of the sides by the use of diagonals, as shown, which assists in the drawing of ovals.

In isometric projection the angle of tilt is 30 degrees. There are no horizontal lines. Fig. 4

shows a cube drawn in isometric. All circles when drawn in isometric are elliptical. To draw the cube the 30-degree set-square should be placed against the T-square. If the sides of the cube are 2 in. long, then every line will be drawn 2 in. long, as all lines are drawn the actual size.

When sketches have to be made away from the shop, isometric projection is out of the question, and angles of tilt, in the case of oblique projection, will be decided approximately. One has to work then without instruments, and probably the sketch is required quickly, but, even when so favourably placed, clear sketches can be made. The examples of the cube do no more than indicate what is meant by pictorial representation, but they explain the principles as thoroughly as a machine detail.

In books on machine sketching very definite and detailed instructions are given for sketching parts correctly, and the apprentice is advised to study these. The main thing is to consider the aspect which shows the features that are of greatest importance, rather than to make a fetish of one form of sketching. A knowledge of sketching is so rare an acquisition, that the apprentice who has devoted time to its study, and can quickly and accurately make a clear sketch, places himself above his fellows.

Use of Explosives in Foundries.

Mr. R. T. Slee, in a Paper read before the Broken Hill Branch of the Australian Institution of Mining and Metallurgy, gave a short account of the experience gained with explosives at the Newcastle (N.S.W.) Steel Works of the Broken Hill Proprietary Company, Limited. The management had decided that as soon as No. 2 blast furnace—which is of an improved design—was ready to be put into commission, No. 1 blast furnace was to be dismantled and reconstructed to a similar design to No. 2 furnace. This reconstruction entailed the removal of the brick lining of the furnace shaft, and also the removal and disposal of the "salamander" and hearth-lining. The method of disposal depends upon the size and nature of the salamander, and in the case under review it was decided to bury it below the hearth of the furnace to be reconstructed. A passage-way was made in the concrete walls of the cast house, and the sand-filling of the cast house removed sufficiently to allow of the concrete foundations of the furnace being reached. This passage-way was extended until the hearth was encountered. The next operation was the removal of the hearth-lining below the salamander. The removal of the concrete was not difficult; holes were drilled with jackhammers, the holes charged with gelignite in the usual way, and the charges fired by ordinary fuse and detonators.

In order to salvage as many as possible of the two bottom rows of hearth blocks, which appeared to be in good condition, the next operation was to remove the concrete foundation below them. The same drills were used for boring, but the size of the bits was increased; every hole as drilled had a water hose placed in it in order to cool its walls and to prevent a premature explosion when charging. When ready to fire, each hose was removed and the charge pushed home; the charge was wrapped in a clay envelope.

While the excavation was proceeding the work of dropping the salamander was also put in hand, and this work called for the drilling of holes around the circumference; in all, 15 holes, each about 4 ft. deep, were drilled; these holes were chambered to receive larger charges of explosive. Before charging them, a strong protecting fence of railway sleepers enclosing the space between the top of the hearth jackets and the tuyere jackets was lashed into position. Each hole was then charged with eighteen plugs of gelignite, and the charges were exploded by current obtained from the power circuit. When the work of removing the débris was completed it was found that the salamander was free all round its circumference. A cement bed was prepared for its reception—the supporting props fired, and the mass dropped; all timber was then removed and the salamander concreted in position, forming a foundation for the new hearth-lining.

On another occasion the metallurgical staff desired to examine the interior of three forging ingots, which were the first ingots cast in the steel foundry using a cast-iron mould. It was desired to split the ingots longitudinally, and it was thought that explosives might be used to bring about this result. The first ingot was drilled with eleven 1¼-in. holes, placed 12 in. apart and 18-in. deep. A trial showed that charges fired for the purpose of chambering had very little effect, the chambered holes only taking from one to two plugs more than the untreated holes in order to give the same depth of charge. Ten holes were charged, the remaining hole being rejected on account of it having ended in slag. The ten holes took 65 plugs; the electric detonators were inserted, and each hole tamped to the collar with clay; the detonators were connected to the firing-wires in parallel. The firing wires were next connected to a two-pole switch connected with the power circuit; by closing the switch the holes were all fired simultaneously. The result was a thin crack the whole length of the ingot, but apparently only about 6 in. deep, as a close examination of the butt-end did not reveal a greater depth. The holes were again charged, using 85 plugs, and fired as before. This time the ingot was split completely in halves.

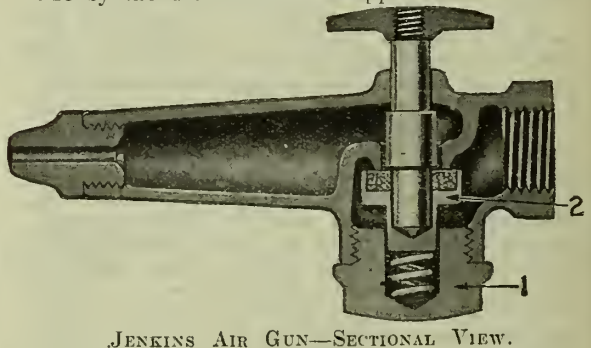
The second ingot was drilled in a similar manner, excepting that about six holes were drilled from the opposite side and arranged to pass between the holes on the other side. The same procedure was followed as in the first case, 85 plugs being used; a crack similar to the one in the first ingot was the result. Thirteen holes were then re-charged, using 65 plugs, and re-fired. The ingot was completely split.

In the third ingot the holes were placed 9 in. apart—27 holes in all, drilled from both sides, and charged with 120 plugs; they were then fired as before. The first explosion completely split the ingot, and also broke the two halves circumferentially.

Explosives were also successfully used at Newcastle for loosening the accretions formed on the bottoms of the open-hearth steel furnaces after a period of operation.

The Jenkins Air Gun.

This is the name of a nozzle with an air-valve of special design, placed on the market by Messrs. Jenkins Brothers, of New York, whose London representatives are at 6, Great Queen Street, Kingsway, W.C.2. The construction is very simple, as will be seen by the sectional view in our illustration. The nozzle and valve are made of high-grade steam bronze in ¼-in. size, and can be attached to hose-pipes of from ⅛-in. to ½-in. size by the use of suitable nipples.



Jenkins Air Gun—Sectional View.

The "gun" can be used for many purposes. Thus, for instance, in the machine shop for blowing out chips, borings, filings, trimmings, for cleaning taps, dies, reamers, lathe and bench tools, milling machines, lathes, grinders, planers, etc. In the foundry it can be used for blowing off cores, cleaning core-boxes, flasks, patterns, and for general dusting. In forges, for tempering tools, and in numerous other places where air is used for cleaning, drying or cooling. When using the gun, the hose is connected with some compressed air supply, the gun is grasped firmly in the hand, and the button is pressed down. To remove the disc, the cap 1 is unscrewed and the disc-holder 2, along with the disc and spring, thus drop into the hand.

Production of Steel Castings.*

By F. Darley.

Scope of Steel Castings.

Forty years ago there were very few steel castings made, and these were only small, plain, and unimportant. To-day we find steel castings everywhere, in almost all shapes and sizes, weighing from a few pounds to upwards of 70 tons, doing service in the engineering world which before their advent was not possible, some of which are wonderful pieces of engineering skill, such as are required for structural parts of our large battle-

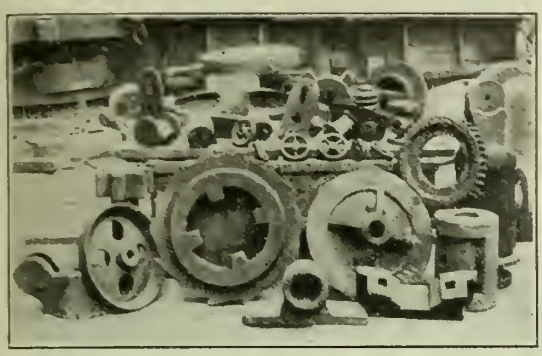


Fig. 1.—A Group of Typical Steel Castings.

ships, giant locomotives, and hydraulic presses, all of which are largely built up of steel castings.

To the inexperienced person it is not easy to realise how all these wonderful pieces are produced, but to the person who really interests himself in the methods of the production of steel castings the art is ever opening and showing new phases and possibilities of improvements.

Production Essentials.

The production of steel castings is essentially an art which can only be acquired by long experience, and involves a knowledge of so many little details which are of the greatest importance. The first stage in the production of anything must be in the hands of the designer, who should have some knowledge of the difficulties in making sound steel castings. Small and unimportant alterations in the design will often constitute the difference between a success and a failure. He puts his ideal on paper through the draughtsman, who works out the required strength, and then makes a working drawing for the pattern-maker to construct the patterns. The pattern-maker must be able to read and understand thoroughly the drawing. He must then consider which is the correct way to mould the job, whether it should be made from a striking board and core-boxes, or it may be a complete pattern or model of what the casting is required to be, or part pattern and part core-boxes, which means that the internal parts, and probably some of the external parts, are made in

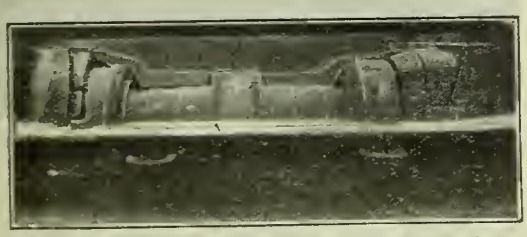


Fig. 2.—Showing Two Half Turbine Cylinders Moulded Together in One Box.

core-boxes of the required shape. Some of these boxes must be made with all the parts complete, others may be made as frames or skeleton boxes, strickled off to shape by means of shaped board. These cores must be the correct size and shape, so that they will fit into their proper positions, and with the pattern form a complete mould. Here is where the art of the pattern-maker is shown. After reading the drawing, he must be able to work accurately, also he must have some engineering knowledge to enable him to construct his pattern in a practical manner. He also must have a fair knowledge of moulding to enable him to decide how his pattern should be made to suit the moulders' requirements. If it should be a complicated and intricate job he should first consult the foreman moulder as to which he considers is the correct way to mould it to enable him to make a sound casting, which must depend very largely on the skill and experience of the foreman, seeing that he must decide which is the correct place from which to run it, also the proper position for his feeding heads, either of which, if in the wrong place, may mean a water casting. The writer firmly believes that a large number of castings are faulty through one of the above being in the wrong place.

Sand a Consideration.

Another consideration which is very important is the correct composition of sand to use, the ramming up or construction of the mould, which must be made sufficiently strong to withstand the strain of the fluid steel, and yet weak enough to collapse at the right moment, to allow the casting to contract during cooling, otherwise there is great danger of the casting pulling itself to pieces. Means of overcoming local strains due to contraction have to be anticipated and met, to obtain satisfactory results. It must be borne in mind that conditions vary with different classes and weight of castings. It will be seen, therefore,

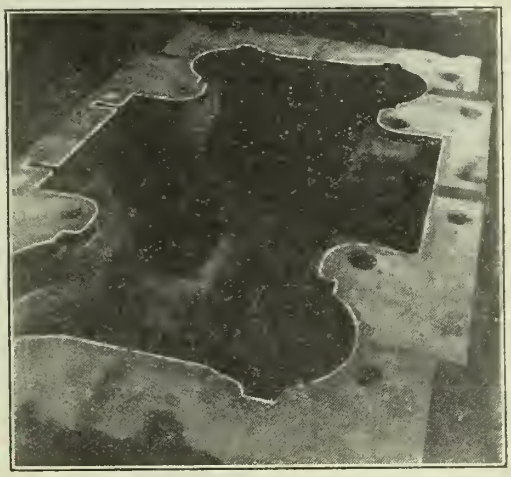


Fig. 3.—The Carcase of a Bed Plate Mould.

that it is impossible to lay down any definite rules in the manufacture of steel castings, as each class of job must be taken on its own and left to the judgment of the foreman or man responsible. Another and the most important consideration of all is that we have metal of the correct composition and temperature, carefully melted and finished: otherwise, no matter how perfect and correct the mould and method of casting may be the castings will not be sound. A general survey of the subject cannot fail to be interesting, as very few people, even those who are accustomed to deal with steel work generally, have very little idea of the many difficulties which present themselves in the production of steel castings, especially where a large variety of work is dealt with, ranging from, say, a few pounds to 50 tons. Fig. 1, however, shows a group of small castings.

Amongst the larger castings are large spur and fly-wheels, ship stern frames, stems shaft brackets, rudders, turbine wheels, cylinders, nozzle boxes, steam valves, strainers, control and main steam valves, some of which are most complicated, and all classes of locomotive castings, some of which are works of art. The introduction of the steam turbine brought forward some very interesting and intricate work in the foundry trades.

* A Paper read before the Sheffield Branch of the Institution of British Foundrymen.

Turbine Wheels.

In the first instance the propellers were driven direct from the turbine shaft. The cylinders were then made in cast iron, moulded in loam, some as large as 12 ft. dia—the *Lusitania*, for instance. The rotor centre wheels were either cast or forged steel. Many difficulties presented themselves in producing these as steel castings.

Some years ago Messrs. Thos. Firth & Sons, Limited, received an order for some about 10 ft.

Fig. 4.—Shows the Same Mould as Fig. 3, but with Cores in Position.

6 in. dia. by 2 ft. 6 in. on the face, with a very heavy boss, and arms cast in, weighing about 18 tons each. The first one was cast successfully, and after allowing it to cool sufficiently to be safe to handle it was taken from the mould while hot, and on account of this a large amount of sand adhered to the casting, which consequently went into the furnace with it. It was heated up to the required temperature, and maintained for several days to allow the heat to penetrate. It was then allowed to cool in the furnace until it was apparently cold, but after being in the shop for three days, and partly fettled, it flew to pieces. There were four wheels of this diameter to make, and this was the start. Therefore, after this first experience it was decided that it was not safe to cast a second on the same lines. What is considered a safe way with a wheel casting of large dimensions, especially with arms cast in, is to split the boss between alternate arms, and fill in the splits with soft metal, and hoop with forged steel hoops. The customers could not allow this in a turbine wheel, as they required them to be shrunk on the shaft. It was therefore suggested splitting the rim between alternate arms, which would have the same effect as splitting the boss, in allowing the arms to contract. The customers agreed to this suggestion, so the rim was split in three places, with cores $1\frac{3}{8}$-in. thick, making provision for machining out the splits, and fitting in steel plates, bolting them together, thereby forming a complete rim, equal to a rim cast solid, with all the casting strains relieved.

The cooling of this casting presented much of interest. Some time after being cast, the top part of the mould was removed, and as the wheel cooled the splits began to open wider, until they measured from $2\frac{1}{4}$ in. to $2\frac{3}{8}$ in., instead of the original $1\frac{3}{8}$ in. arranged for. This was one of the most instructive examples one could have of the process and effect of contraction in large castings. The rim being the thinnest part of the casting would naturally cool first and contract the quickest, but being split was free to close in as the boss and arms cooled afterwards, until the splits came to be $1\frac{1}{2}$ in. to $1\frac{5}{8}$ in. instead of the original $1\frac{3}{8}$ in. This slight difference would probably be caused by the resistance of the arm cores.

Considering now the strains a casting of this class must be subject to, if cast in a solid piece without splits. If it does not break the contraction would inevitably take place just in the same manner. Firstly, the rim would probably stretch so much, and would put a compression upon the arms, when the rim has practically finished contracting, the arms and boss continue to contract until they are quite cold, some time after the rim has reached this stage.

This uneven cooling sets up a very severe tension on the arms, so much that a very slight shock such as a blow from a hammer, or a bump, would cause one or more of the arms to break.

The success of the experiments with split arms became widely known, and within a few months following the principle was adopted by the Admiralty and all the leading marine engineers; in fact, it is not thought that anyone asked for a turbine wheel over 5 ft. dia. to be cast without being split in the rim within 12 months after the first one had been made.

Turbine Constructional Details.

The steam turbine to be efficient must be run at high speed, which is not satisfactory for the screw propeller. The most efficient speed for the screw propeller is below 200 revs. per min. This was the reason the turbine cylinders in the past were built so large to get high power at a moderate speed. But of late years this has been revolutionised by the introduction of the geared turbine, which instead of driving the propeller direct from the turbine shaft, as was the custom when the turbine was first introduced for marine work, it is driven by means of a small pinion on the turbine shaft into a wheel four to ten times the dia. on the propeller shaft, and in some cases there are two sets of reduction gear thereby reducing the speed of the propeller to the most efficient and correct speed.

Turbine Cylinders.

This system has completely revolutionised the marine turbine, doing away completely with large diameters, and introducing high pressure, high speed, and small diameter turbines, which means that large centre wheels are no longer required; the small ones are made as forged discs, but, on the other hand, on account of cast iron not being satisfactory for high-pressure superheated steam, the high-pressure turbine cylinders, steam valves, and nozzle boxes are now called for as steel castings, which requires the highest skill in the art of pattern-making and moulding. Two patterns and 16 core-boxes are required. In this job there are so many complicated cores, ports, branches, webs, feet facings, and uneven thicknesses which appear to make it almost impossible to make a sound casting. Here is a problem: first, how to mould the job, how and where to run it, and how to feed it so as to make it sound. This is an important and difficult point, and requires some serious thought, and is generally overcome by reducing some of the thick parts where practical, or by adding feeders alongside the thin places in order to reach the thick parts which require to be fed. This must be very carefully considered or it will cause the casting to pull on account of uneven cooling. Fig. 2 shows the mould of two half-small turbine cylinders moulded together in one box, which in this case is done for convenience, having a moulding box at liberty suitable for two castings. These cylinders are moulded from two full patterns and are made joint, or flange down, to enable the moulder

Fig. 5.—The Bed Plate Mould Weighted Down Ready for Casting.

to fix the cores, which form the internal parts, the outside being moulded by means of separate parts or drawbacks. These are all moulded on to the pattern, being built up by bricks and sand supported by cast-iron grids, all jointed in such a position as to enable the pattern with all the various branches, ribs, feet, bosses, and other projections to be removed. In this mould there are 16 loose parts or drawbacks and over 30 internal cores. After the outside mould is built up and the top part, which holds the whole lot together, moulded, every part is carefully marked and numbered and then taken to pieces to be finished and dried. The pattern is now withdrawn and the mould dried, when all the parts are gathered together ready to be assembled. The

cores which form the inside parts are first placed in their correct positions, and secured so that the flow of metal will not displace them, after which the drawbacks, which form the outside of the mould, are fixed and secured in their respective positions. As the moving of a core or drawback may mean a waster of a very expensive casting, last of all the top part is placed in position and securely clamped ready for casting.

Large Diameter Cylinders.

When these cylinders are required in large diameters some difficulty is often experienced in keeping them in the correct shape. It is found that on machining, some of them have not contracted across the joint, and are ¾ in. too wide, and will not machine up in the bore, the difficulty being now to bring them in, so that the bore would machine up. They are very strong on account of having one end cast in, also various ribs and feet cast on. In an instance encountered by the writer, first local heating was tried, and then screw rods, etc., but it would not move, therefore, it was decided to let the annealing furnace do the job. Three strong clamps were obtained and fixed across the wide part along the joint and wedged on. The casting was then placed with the clamps down in the furnace, the clamps being buried with sand and fire-bricks, so that the heat could not get to them and expand them. The casting being exposed to the heat of the furnace was bound to expand, but being held by the cramps at the joint flange caused the casting to close in and bring it into its proper shape. This treatment proving a success, it has been adopted on several occasions with equally successful results.

A large rotor spider centre is moulded by means of a striking board and core-boxes. The bottom part is struck up from a centre spindle and striking board while the outside of the mould is formed by large segment cores fixed together, true, by the centre spindle and board. After they are all fixed, the centre spindle is removed and the centre core fixed, after which the outside is rammed up with old sand to hold the mould in position sufficiently strong to withstand the strain of the molten metal. The top part is now fixed and secured fast to the mould, which is then cast. It must then remain in the mould at least 5 or 6 days so that it may cool evenly. It is then taken into the fettling shop and the sand removed, the head parted off, and, after fettling, annealed.

Making Large Base Plate.

Fig. 3 shows the outside portion of a mould for a large base plate for a 2,000-tons' press. This mould is formed without a pattern by means of cores made in special core-boxes. First a pit is prepared in the foundry floor sufficiently deep to bury the job. A suitable foundation, by means of a coke bed, is carefully prepared and covered with several inches of sand rammed down firmly and strickled off level. It is then dried by coke fires, cleaned, and centre lines set out at right angles, from which the shape of the mould is marked. The cores are then fixed to the marks in their correct position, one by one, until the complete outside of the mould is formed. Temporary stays or props are fixed inside, so that the outside walls of the cores can be rammed up firmly and hard, so that it will stand the strain of the molten metal when cast. When the outside is made secure the temporary stays are removed, and the inside cores are fixed. These form the holes for the columns, and the thickness of metal ready for the top part, which is now fixed, as is shown in Fig. 4. The securing of this is very important on account of the tremendous lift or strain there is on this caused by the liquid pressure from the feeding heads being so much higher than the level of the casting. This requires the equal to about 100 tons deadweight to hold down the top part. The fixing of this is an engineering job, and is illustrated in Fig. 5. The weights are fixed on steel girders placed across the top of the mould, which must be so packed that there is no weight actually on the top part or there would be a danger of crushing the mould. The top part is then packed tightly underneath the girders, but evenly distributed so as not to crush the mould, which would mean a waster casting. It is now ready for casting. It is then cast from two runners to enable it to run up quickly. It should then be left in the mould until it is cold, which will be about two weeks, after which it is lifted from the mould and taken into the fettling shop. Here all the inside cores should be removed first, so that the air can get through and allow it to cool thoroughly, after which the sand is cleaned off and the heads parted off by means of a cold circular-saw. The casting, shown in Fig. 6, is now ready for annealing. It is put into the furnace and heated up gradually to 850 deg. C., the heat being maintained for about 24 hours to allow the temperature to be even throughout when the casting-structure should be thoroughly broken down. It should then be allowed to cool down in the furnace with the doors closed. It is now taken out of the furnace and finished ready for delivery.

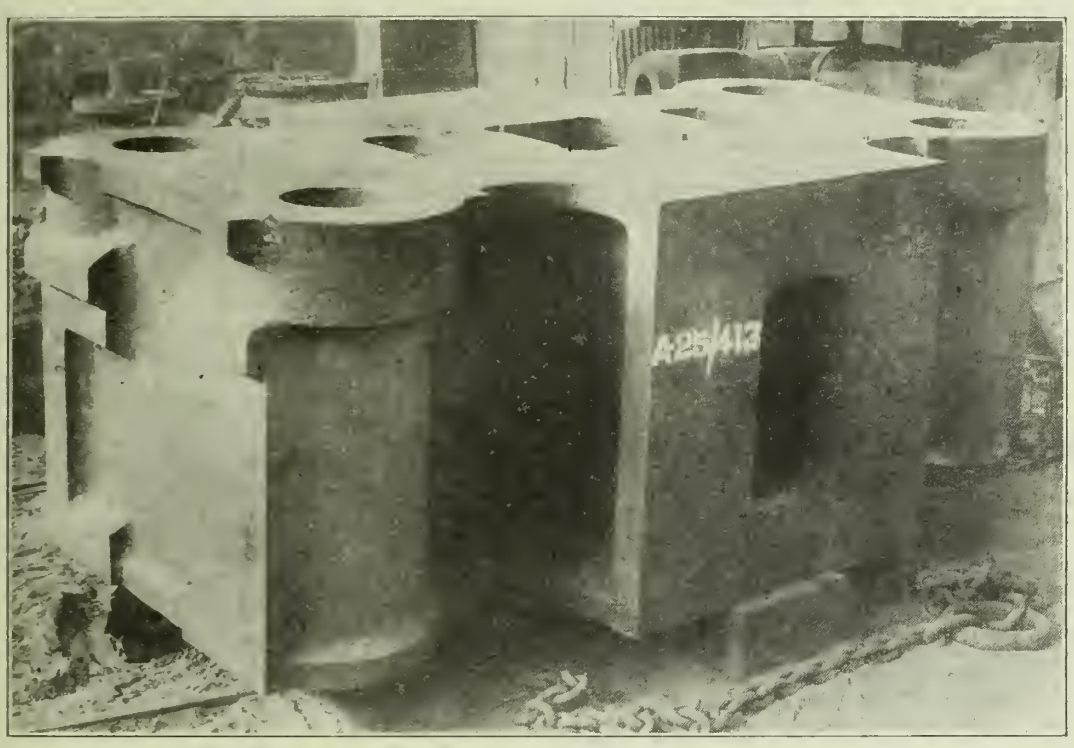


Fig. 6.—The Base Plate Casting Ready for Annealing.

Moulding a Spur-Wheel.

In Fig. 7 is illustrated a large double helical spur rim, for use in a rolling mill, being moulded in the floor. First, a pit is prepared

about the depth of the casting, and a sound foundation made, properly vented by means of cinders or other porous material. A sand face is then rammed up and struck to the correct shape by means of a striking board, worked on a centre spindle; next the outside of the mould is built up with bricks and slurry, not mortar. The wheel-moulding machine is now placed in the centre of the mould, the arm bolted to the table which carries the slide on which the tooth block is fixed, and held in position in the mould until the tooth is rammed, after which the block is withdrawn. The machine is then moved round the exact fraction

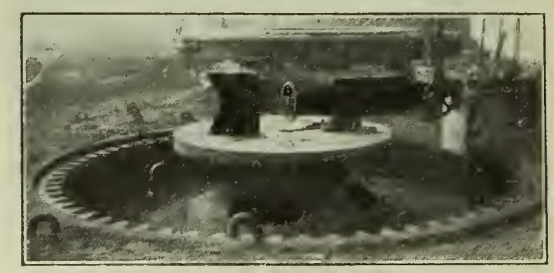


Fig. 7.—Moulding a Double Helical Spur Wheel.

of a circumference required for the correct number of teeth. This is done mechanically by means of change wheels, similarly to a screw-cutting lathe, worked out to get the correct movement by so many turns of the handle shaft. The teeth are all rammed up one by one until the wheel is complete. The mould is then dried and the cores which form the inside are placed in position ready for the top part, which is then put on and the job cast. It must be allowed to remain in the sand until cold, after which it is lifted, fettled, the heads parted off, annealed and finished ready for delivery. This rim was $\frac{3}{4}$ in. oval after it came out of the annealing furnace, but it was tuned up to within $\frac{1}{8}$th of an inch before delivering.

(To be continued.)

Sulphur from Blast-Furnace Slag.

In a recent article in "Stahl und Eisen," Professor L. H. Diehl, of Oberhausen, describes and discusses his process for the recovery of sulphur from blast-furnace slag. After referring to the importance of sulphur in modern industry, and to the fact that before the war about 1,000,000 tons of pyrites, 250,000 tons of blende and 30,000 tons of sulphur were imported into Germany each year, he states that during the war every effort was made to increase the output of German deposits of pyrites and zinc blende, and efforts were made to obtain sulphur from the large beds of gypsum and anhydrite (natural anhydrous calcium sulphate). Unfortunately, efforts in these directions have not been entirely successful, and there is to-day a scarcity of sulphur in Germany. It was therefore desirable to investigate every available source of sulphur, which led the author to work on blast-furnace slag. Even if its sulphur content is small, the total amount is very large.

The slag production in Germany before the war was about 20,000,000 tons, with sulphur running from 1 to 2.25 per cent. and averaging 1.50 per cent. This represents at least 300,000 tons of sulphur thrown away each year. Because of this large available supply, efforts were made to develop a process for its recovery.

The Diehl process consists in obtaining sulphuric acid by oxidation of the calcium sulphide in blast-furnace slag by air or by sulphates such as gypsum or anhydrite, with the help of air. The chemical reactions are:—The calcium sulphide unites with oxygen and gives lime, which changes to orthosilicate, and at the same time free sulphur is liberated. With sufficient excess of air, this is burned and, if not, it passes off unburned with the gases.

Because of the low sulphur content of blast-furnace slag, which precludes remelting or subsequent treatment, all the work was done on the molten slag as it came from the furnace by blowing air through it. Preliminary tests carried out with molten slag and oxygen gave a gas containing 23.1 per cent. SO_2 by volume. Further experiments showed that slot-shaped tuyere gave a richer gas than a round one. Following these tests an apparatus was designed that has been used successfully for several months at Gutehoffnungshütte. When the apparatus is warm and the slag hot and fluid, the pressure is from about 2 to $3\frac{1}{2}$ lbs. per sq. in., but often rises to about $4\frac{1}{2}$ lbs. if the slag is colder, due to the formation of a spongy solid slag above the tuyeres.

At the end of a run of slag, the tapping hole is opened and the slag drained off. The working door is opened next, and the crusts and scales around the tuyeres broken and removed. The slag coating on the apparatus itself is allowed to remain unless it breaks off automatically, as it protects the metal against sudden changes of temperature, and also serves as an insulator for the slag, preventing unnecessary cooling.

The sulphur output is higher as the slag is hotter and higher in sulphur. Acid slags give off sulphur more easily and more thoroughly than do strongly basic slags. However, the latter are usually hotter and higher in sulphur, so that good results are obtained.

The change in appearance of the slags after treatment is interesting. Slags with large amounts of calcium sulphide are milky because of numerous needles of sulphide. Such slags, after treatment, become completely clear and glassy, a proof that the sulphide is decomposed and the lime dissolved in the body of the slag. In some cases, with high-sulphur slags and insufficient air, free sulphur is produced.

If the gases produced in the process are conducted through iron pipes, an incrustation of white salts is produced, consisting almost entirely of potassium bisulphate. The temperature of the gases is about 930 deg. to 950 deg. C., measured away from the range of radiation from the fluid slag.

The gases obtained by the Diehl process contain on the average 6 to 7 per cent. SO_2, small amounts of CO_2 (from 1 to 1.2 per cent.), and about 10 per cent. oxygen, while the rest is nitrogen. There is entire freedom from arsenic, chlorine, fluorine, carbon monoxide, sulphur and dust or similar impurities, except for small amounts of potassium bisulphate, which can be easily removed. The gas is therefore remarkably suitable for the production of specially pure sulphur products. A very rich gas can be obtained if a sulphate such as calcium sulphate is added to the slag while air is blown in.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Semi-Steel.

To the Editor of The Foundry Trade Journal

Sir,—As a practical man, the methods I recently employed when manufacturing a 4-ton cast of semi-steel may be of interest for your readers.

Considering that a good temperature is essential, I first ran through 4 tons of grey iron. This, of course, provided a good hot cupola. Then 2 tons of 20 per cent. semi-steel was put through, followed by a further 2 tons of 10 per cent. material. The casts were handled by four 12-cwt. bogie ladles. Though the weight of the castings ranged from a few lbs. up to 2 cwts., there would not have been the slightest difficulty in making a 5-ton casting, as the metal came down as quickly as it could be handled, and at a white heat. Under such conditions it does no harm to allow the cast to stand for a short time, but obviously it must be done with discretion. The cupola used is 52-in. dia. and provided with eight tuyeres. The semi-steel was all poured within 20 mins. and the moulds all cast up within 30 mins.—Yours, etc.,

J. Mc. E.

Mr. J. Longden, who has been acting as assistant secretary to the London Branch of the Institution of British Foundrymen has been appointed Foundry Superintendent to Messrs. D. and J. Tullis, Limited, Kilbowie Ironworks, Clydebank, Glasgow.

Company News.

Pinchin, Johnson & Company, Limited.—Interim ordinary dividend, 5 per cent. actual.

United Steel Companies, Limited.—Payment of half-yearly dividend on cumulative preference shares postponed.

Dalmellington Iron Company, Limited.—Final ordinary dividend, 6d. per share, free of tax, making 5 per cent. for the year.

James Brookes (Birmingham), Limited, 343, Bradford Street, Birmingham.—Capital £8,000, in £1 shares. Ironmasters.

Short Bros., Limited, Pallion, Durham.—Capital £300,000, in £10 shares (15,000 preference and 15,000 ordinary). Shipbuilders.

Scottish Iron & Steel Company, Limited.—Dividend, 6 per cent. per annum, less tax, for half-year, on 6 per cent. cumulative preference shares.

Lorimer Brothers, Limited, 20, Dixon Street, Glasgow.—Capital £3,000. Engineers, etc. Directors: J. A., Wm. R. D., and J. Lorimer.

E. C. Ogden & Company, Limited, 4, Clerkenwell Green, London, E.C.—Capital £5,500 in £1 shares. Engineers. Directors: E. C. Ogden and L. W. Ogden.

Gibson Brothers (Hebden Bridge), Limited, Osborne Works, Hebden Bridge, Yorks.—Capital £2,000 in £1 shares. Engineers. Directors: S. Gibson and J. R. Ashworth.

D. J. MacDonald, Limited, South Street, Roques, Dundee.—Capital £50,000. Engineers, etc. Directors: D. J. MacDonald, W. R. MacDonald, and Miss M. Y. MacDonald.

L. Withers Green, Limited, 110, Victoria Street, London, S.W.—Capital £3,000, in £1 shares. Engineers. Directors: G. E. Brine, L. Withers Green, R. A. Robertson, and C. T. Witt.

Dunn & Company, Cheltenham, Limited, 21, Bath Street, Cheltenham, Glos.—Capital £2,000. Electrical and general engineers. Permanent directors: W. E. Thomson and A. E. Dunn.

Sharpe & Peterson, Limited, 28, Royal Exchange Square, Glasgow.—Capital £1,000. Designing, mechanical, structural and general engineers, etc. Directors: D. Sharpe and D. C. Paterson.

Monk Bridge Iron & Steel Company, Limited.—Brought forward, £43,597; loss, after adjusting taxation and providing for bank interest, etc., £17,621; available, £25,976; dividend on cumulative 6 per cent. preference paid; carry forward, £10,976.

Blands, Limited, South Knighton Garage, Knighton Church Road, Leicester.—Capital £4,000 in £1 shares (2,500 7 per cent. cumulative preference and 1,500 ordinary). General engineers, etc. Directors: E. Bland (permanent governing director) and H. W. Bland.

R. H. Piggford & Company, Limited, 21, Telegraph Buildings, Sheffield.—Capital £7,000, in £1 shares, to take over the business carried on as "R. H. Piggford & Company," of engineers, manufacturers of oxy-acetylene and other welding plant, etc. Permanent directors: R. H. Piggford and G. N. A. Pitt.

Personal.

THE LATE MR. F. MOSES WINTER, Abbeyfield Road, Sheffield, a director of Ibbotson Brothers and Company, Limited, left £1,979.

MR. C. T. BARLOW has resigned his seat on the board of Accles & Pollock, Limited, weldless steel tube manufacturers, of Oldbury.

MR. W. HUNTER, for many years head of Hunter, Hardin & Wilson, Glasgow, who died on March 9, left personal estate valued at £27,539.

MR. A. W. MAYCOCK has been appointed manager of the machine, tool, etc., department of Martin Bros. (Machinery), Limited, of Bridge Street, Manchester.

THE LATE MR. ALEXANDER SIMPSON, J.P., of St. Elmo, Craighall Road, Leith, Edinburgh, a director of Redpath, Brown & Company, Limited, left personal estate valued at £28,747.

ENGINEER VICE-ADMIRAL SIR GEORGE GOODWIN, late Engineer-in-Chief of the Fleet, and Dr. James Colquohoun Irvine, Vice-Chancellor and Principal of St. Andrew's University, have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

Japan to Make Tinplate.—The Imperial Steel Works at Yawata, Japan, has completed construction of its plant for making tinplate. This plant was erected with a view to checking imports of tinplate from America. Its estimated annual capacity is 20,000 tons, although the first year's production is not expected to exceed 6,000 tons.

Contracts Open.

Dundee.—Supply of 30 malleable iron seats, for the Town Council. Mr. J. Thomson, city engineer, 91, Commercial Street, Dundee.

Johannesburg, September 27.—Supply and delivery of 1,475 brass cocks, for the Johannesburg Municipal Council. The Department of Overseas Trade (Room 49), 35, Old Queen Street, Westminster, S.W.1.

Swansea, September 8.—Supply and delivery of the following, for the Swansea Town Council, viz.:—(1) Cast-iron pipes and specials; (2) waterworks appliances, including valves, hydrants, etc.; (3) water meters. The Water Engineer and Manager, Guildhall, Swansea.

Swansea, September 8.—Stores, ironwork, etc., for three or six months from October 1, for the Town Council. The Borough Engineer and Surveyor, Guildhall, Swansea.

Nantwich, September 22.—Supply of the following, for the Nantwich Rural District Council:—(Contract No. 1) cast-iron water pipes, branches, and other pieces; (2) hydrants, sluice valves, fittings, etc. Mr. H. Crabtree, engineer, 1, Dysart Buildings, Nantwich. (Fee 10s., returnable.)

Ruskington, Lincs., September 18.—Supply, laying and jointing of about 2⅞ miles of 2-in. diameter cast-iron main, irregulars, valves, and other works of water supply, for the Ruskington Urban District Council. Mr. S. F. Clare, engineer to the Council, Sleaford. (Fee £1 1s., returnable.)

Gazette.

MESSRS. J. HARGREAVES, JUNR., J. Hargreaves, Senr., and R. Boulger, pattern makers, 7, Charles Street, Manchester, trading under the style of the City Pattern Company, have dissolved partnership.

A PETITION for the winding-up of Fuller's United Electric Works, Limited, was presented on August 18 by W. S. Caines, Limited, of Andover House, The Broadway, Plaistow, creditors of the company. The petition is to be heard in London on October 17.

THE partnership heretofore subsisting between Jane Lamb, Ellen Douthwaite, William George Merriman and the late Hartley French, carrying on business as chain and anchor merchants, at the Mill Dam, South Shields, under the style of G. Lamb & Son, has been dissolved. Mr. William George Merriman will continue to trade alone under the style of G. Lamb & Son.

AT the expiration of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies, and the companies will be dissolved:—Aeronautical Engineering Company, Limited; Aero Sheet Metal & Engineering Works, Limited; Anderson's Shipbuilding & Repairing Company, Limited; Brooks Motor & Engineering Works, Limited; Clutchnut Engineering Company, Limited; Engineering and Aircraft Construction Company, Limited; Expert Metal Workers, Limited; Gerrard Engineering Works, Limited; Ingate Engineering Company, Limited; International Electrical & Mechanical Supplies Company, Limited; Lattimer Engineering Company, Limited; Lubros Engineering Company, Limited; Ostroyd Engineering Company, Limited; Pressure Casting Company, Limited; Slough Metal Company, Limited; Southern Shipbuilding & Engineering Company, Limited; T. W. Field Engineering Company, Limited; United Electrical Works, Limited; Warstone Engineering Company, Limited; West Ham Engineering Company, Limited.

The Institution of British Foundrymen,

At a General Council Meeting, held at the Midland Hotel, Manchester, on September 2, the following were accepted for membership:—

The Staveley Coal & Iron Company, Limited (Lancs.).

John N. Bentley (W.R. of Y.).
Albert H. Lewis (Lancs.).
Chas. P. Markham (Lancs.).
Jerry Stones (Gen.).
John Pinder (London).
Robert Pinder (London).
John Boyle (W.R. of Y.).

The following were elected Associate Members:—

W. Hird (W.R. of Y.).
Charles A. Howe (Gen.).
Arthur Phillips (Lancs.).
James Houghton (Coventry).
Joseph Hibbert (London).
Thomas Hull (W.R. of Y.).

Trade Talk.

SMITH'S DOCK COMPANY, LIMITED, have booked orders for six powerful tugs and two trawlers.

THE IMPORTS of foreign iron ore at the Lonsdale Dock at Workington last week amounted to 1,365 tons.

H. INCLEDON & COMPANY, LIMITED, tube manufacturers, are establishing a branch at 18, Ludgate Hill, Birmingham.

WALLIS-JONES & DENT, consulting engineers, have removed to 50, Queen Anne's Gate, Westminster, London, S.W.1.

THE JEARY ELECTRICAL COMPANY, LIMITED, 8, Lambeth Hill, London, E.C.4, are establishing a branch at 97, Queen Victoria Street.

THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION is arranging for a municipal visit to Paris to inspect the generating station.

MISS C. GRIFF, who is chairman of the Women's Engineering Society, has established the Stainless & Non-corrosive Metal Company, 14, Weaman Street, Birmingham.

THE members of the Manchester branch of the Institution of Locomotive Engineers will visit the Dukinfield Carriage and Wagon Works of the Great Central Railway on September 13.

PALMERS SHIPBUILDING & IRON COMPANY, LIMITED, Hebburn, have received an order to carry out extensive alterations and repairs to the steamer "Ascanius," owned by Alfred Holt & Company, of Liverpool.

TENDERS for the building of the new floating dock at Southampton to the order of the London & South Western Railway Company have been invited, and must be in the hands of the company by September 6 next.

COCHRANE & SONS, LIMITED, of the Ouse Shipbuilding Yard at Selby, have recently launched from their premises two steel lighters which have been made to the order of the Grimsby Coke, Tar and Coaling Company.

THE directors of the Leeds Forge Company, Limited, state that owing to depression in trade, and the loss caused through the engineers' strike, it is not proposed to pay the usual interim dividend on the preference shares.

THE members of the Newcastle and District Branch of the Institution of British Foundrymen held a meeting on Saturday last, at the Neville Hall, Newcastle-on-Tyne, when a lecture was given by Mr. D. McLain, of Milwaukee, U.S.A., on "Semi Steel and Cupola Practice."

THE GLASGOW CORPORATION have decided by a very small majority to accept the American tender for tramway rails. It may be remembered that the United States concern quoted a figure amounting to £15,325, and that an English firm was second lowest with £18,262, while others ranged up to £18,600.

AT the meeting of the shareholders of the Tata Iron & Steel Company, Limited, the directors accepted a suggestion that there should be a dividend paid on the ordinary shares, and they fixed the dividend at a rate of 4 per cent per annum. Previously they had recommended that no dividend should be paid on the ordinary shares.

A BALLOT is now being taken among workers in the iron and steel trades to decide whether the sliding scale agreement of July, 1921, for the regulation of wages shall be cancelled or not. The votes are returnable on September 26. The societies concerned are the General Workers' Union and the National Amalgamated Union of Labour and others.

A CONFERENCE will be held on September 12 at Edinburgh between representatives of the Shipbuilding Employers' Federation and the Executive Committee of the Federation of Engineering and Shipbuilding Trades. At this conference the employers will propose that the remaining 10s. of the war bonus of 26s. 6d., paid in abnormal circumstances, shall be discontinued, and that wages thereafter be stabilised.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to W. J. J. Lowther, 146A, Queen Victoria Street, London, E.C.4; Ed. Plummer, 29, Mirador Crescent, Swansea; Russell, Marshall & Company, Limited, 9, St. Thomas Street, London Bridge, London, S.E.1.; H. B. Sparrow, 65, Fenchurch Street, London, E.C.3; and Watts & Nephew, Limited, Allcock Street, Metal Works, Birmingham.

RENTON & FISHER, Hopetoun Works, Bathgate, Scotland, have ordered from the Volta Manufacturing Company, Limited, of Welland, Ontario, Canada, a three-ton "Volta" electric furnace, which they propose to erect at their works. The Volta Manufacturing Company are represented in Great Britain by T. Rowlands & Company, Limited, 23-27, Broomhall Street, Sheffield, and the furnace which Messrs. Renton & Fisher are installing is the first of this make to be erected in Great Britain.

THE ANDERSON GRICE COMPANY, LIMITED, of Carnoustie, have secured an order from the Abertillery and District Water Board for two electric 1000 cranes, for service in the construction of the Gryne Fawr Reservoir. These cranes will be of the 3-motor type, and will have an effective radius of 40 ft. and a lifting capacity of two tons. The motors are being supplied by J. P. Hall & Company, of Oldham, and the control equipment is of British Thomson-Houston manufacture. There was keen competition for the order from abroad.

THE RETURNS from the Clyde shipyards in August show that fourteen vessels, aggregating 53,123 tons, have been launched. This is the largest monthly output this year. For the same period last year the tonnage was 34,665. The most notable vessels launched have been a motor vessel for the Royal Mail Steam Packet Company and a geared turbine steamer for a French shipping firm, both of 9,000 tons gross. The only new contracts reported are two cable steamers by John Brown & Company, Limited, two cargo steamers by the Charles Connell Company, and a British India vessel by Barclay, Curle & Company, Limited.

THE BOARD OF TRADE have now received the reports of the Committee, appointed under the Chairmanship of Sir Charles Stewart, to inquire into three separate complaints under Part II. of the Safeguarding of Industries Act, relating to wire nails manufactured in Germany, snap fasteners manufactured in Germany and Czecho-Slovakia, and hooks and eyes manufactured in Germany. The reports, which will be published and presented to Parliament, are not to the effect that the conditions laid down in Section 2 (1) of the Act are fulfilled. Consequently, in view of the provisions of Section 2 (3) of the Act, the Board of Trade are unable to take any further action in respect of the complaints in question.

IT IS NOW ANNOUNCED that no agreement has been reached between Lithgows, Limited, shipbuilders, of Port Glasgow, and the Boilermakers' Society regarding the construction of ships at pre-war or other special rates of wages. The vessel on which work has been started is a small steamer contracted for in the ordinary way of business, and not one of the four which the firm proposed to lay down under their special scheme. It is added that the men are still opposed to accepting pre-war rates, that their Society has asked the shipbuilders for a conference to consider the whole question of price list payments, and that until this conference is held nothing will be done regarding starting work on the proposed relief ships.

THE GENERAL SLACKNESS of trade was dealt with by Mr. A. F. Nicol, who presided at the meeting of the Chesterfield Tube Company, Limited, in London last week. He said that when they met last year he had expressed the hope that they would see a return of stable and bright conditions, both with labour and with trading. In the labour sphere those hopes had been to some extent realised, but from the important standpoint of general business, on which their own well-being and also the actual employment of labour depended, their hopes had not fructified at all—quite the reverse. There never had been so disappointing a time to many old-established manufacturing trades as the year which had just gone by. It had not been a question of good or bad management, or of well or indifferently equipped works. Neither management nor equipment could have altered the fact that in most lines of trade the volume of demand had been deplorably short of normal.

Wabana Ore for Nova Scotia.—We stated in "Canadian Notes" on June 30 last that under an agreement between the British Empire Steel Corporation and the Newfoundland Government the 25-cent. royalty is to continue in force until December, 1940, but in the event of failure on the part of the Corporation to carry out its agreement, an export tax of $1 per ton will be imposed by the Newfoundland Government upon all ore mined and shipped abroad, except to the Canadian Province of Nova Scotia. According to a statement in a Canadian paper by Mr. R. M. Wolvin, President of the British Empire Steel Corporation, the agreement with the Newfoundland Government (as quoted in the volume on the iron ore of British America recently issued by the Imperial Mineral Resources Bureau), includes the following provisions:—(1) All ore shipped to Nova Scotia shall pay an export tax of 25 cents per ton. If the annual shipment to Nova Scotia is a million tons or over, ore may be shipped to other points in Canada without tax; if less than a million tons, the tax of 25 cents shall be paid up to a million tons. (2) Ore may be shipped free of tax to countries other than Canada, provided the company spend three million dollars during the next five years on improvements and developments in their plants, and that they give notice before January 1, 1926, of their intention to erect in Newfoundland a smelting plant of 100,000 tons annual capacity, else a tax of 10 cents per ton will be levied on such ore.

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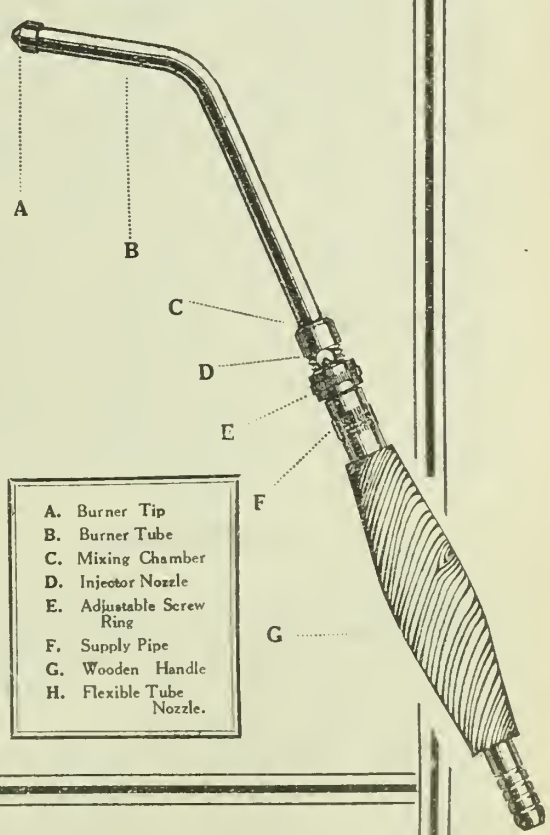

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IRON AND STEEL MARKETS.

Pig-iron.

Only slow, if steady, movement towards return to normal conditions can as yet be recorded as concerns pig-iron markets, in which, however, a distinctly better feeling is expressed now that active business has recommenced after the holidays. Among the more promising signs pointing in this direction are the re-opening of iron-ore mines in several localities, and an increase in the volume of inquiries, slight, perhaps, on home consumers' account, but substantially augmented by American demands, due to current labour difficulties, which are hampering blast-furnace production in the States. Competition in the home markets is also growing more active, Midland producers of pig-iron now pressing sales in Scotland, formerly almost entirely monopolised by the Cleveland makers, aided largely by the seaboard facilities for transport to Clyde-side. Another factor in the present position is the slackness at the foundries, work in this industry being extremely irregular, some branches being fairly well off for orders, while others supplying principally the engineering firms are only partially employed, the Lancashire districts reporting that most makers of iron castings are operating on an average about two days per week. In the Manchester market, at one time an important buying centre for Scotch pig, the high prices now demanded for that quality iron are almost prohibitive, and in consequence foundrymen are now turning attention to North-East Coast hematite, which can be bought almost as cheaply as Cleveland No. 3 G.M.B. On Tees-side, business was practically suspended last week, owing to the annual festival at Stockton Races, and market movements were therefore confined within very narrow limits. Demand on Continental account has been on a restricted scale, owing to the demoralisation of European exchanges, but it is satisfactory to note that last week a cargo of iron was despatched to Czecho-Slovakia, quite a new departure in the Tees-side export trade. At the moment, however, the American demand is the dominant feature of the Cleveland trade. How long this movement will continue it is impossible to say, but in all probability it will prove to be merely temporary, and it is due mainly to the needs of consumers near the Atlantic seaboard, whose supplies from inland have been stopped by the interruption of the rail haul. Last week, further large cargoes of foundry iron to a special analysis have been shipped, while more inquiries are now coming to hand for the ordinary standard quality, some substantial lots of which have already been sold. These sales to the United States have had the effect of reducing stocks, but so far they have not offered a sufficient inducement to makers to put in more furnaces. But prices have naturally shown a rather firmer tendency, and No. 3 G.M.B. is strong at 87s. 6d. per ton. The scarcity of No. 1 and silicious iron keeps the price steady at the high figure of 95s., No. 4 foundry is now nearer 86s. than 85s., with No. 4 forge at 84s., and mottled and white 80s. At Middlesbrough, business in hematite is rather better, but still inclined to irregularity. Home inquiry shows some improvement, but the export trade is very quiet, although a few parcels have gone to Italy, notwithstanding the depreciation of the lire. East Coast mixed numbers can be bought without difficulty at 89s. per ton, both for home and export, and even this figure can be shaded against firm offers. Hence there is barely a margin of 1s. 6d. between Cleveland No. 3 and hematite, a position which is practically unprecedented in the history of the trade. West Coast hematite shows some slight acceleration of activity, shipments being on an improved scale, although the home demand is still quiet. Prices are unchanged, with Bessemer mixed numbers quoted at £5 5s. per ton delivered Glasgow or Sheffield.

Finished Iron.

The lethargy so long prevailing in the markets for finished material has only been moderately relieved during the past month, nor is it considered probable that any really practical improvement will eventuate until the present quarter is ended. Buyers continue to hold off markets in the somewhat fallacious hope of an early substantial reduction in current quotations, which manufacturers declare quite out of the question while costs of production remain at present levels, and consequently specifications are only placed for immediate requirements. Yorkshire makers of bar iron report conditions unchanged, the demand not having improved to any substantial extent, and it looks as though it may be some time before business becomes more active. Swedish bar iron for the crucible trade is quoted here at about £17 5s. per ton, with not much doing. In South Staffordshire, work in the finished iron branches has been resumed, but there is very little change in the general conditions. The demand for nut and bolt iron is not so active as it was, but makers still have a few unexecuted orders on their books under which deliveries are being taken steadily, and they are hopeful that as these are worked off new ones will be forthcoming. In the meantime the quotation is maintained at £9 17s. 6d. There is still some movement in fencing bars at £10 to £10 2s. 6d., although here also buying is somewhat slower. For better qualities of bar iron demand is erratic, and the prices quoted are still very wide, much wider than used to be the case. Normally there should always be some range of quotations for the better qualities of unmarked bars, owing to the corresponding range in quality, but the present variation is most exceptional. Rather more business has been passing of late in gas strip. There is nothing fresh to report concerning marked iron, makers of known brands enjoying a fairly steady flow of specifications, though the majority would unquestionably favour a fuller volume of forward orders to ensure regularity of working.

Steel.

Business in most sections of the steel industry bears a rather more hopeful appearance, an exception having to be made in the case of high-speed qualities, which continue depressed, especially as concerns the American market, where the passing of the new Tariff Bill has had an adverse influence on one, if not the only outlet for the world-famous brands of high-speed metal, of Sheffield manufacture. There is some business in the cheaper steels, and overseas buyers, realising that prices are unlikely to go much lower, are placing contracts with more freedom. There is a fair amount of buying of railway and motor-car steel, but there is still plenty of room for improvement.

Scrap.

Reports from the various markets for scrap metal indicate a somewhat better outlook, although buying at the moment is chiefly confined to consumers' more urgent requirements. Prices on the whole are steadily maintained, and at Middlesbrough rule at about the following figures:—Heavy steel scrap, 65s.; steel turnings and c.i. borings, 47s. 6d. to 50s.; cast-iron machinery scrap, in handy pieces, 67s. 6d.; heavy wrought-iron ordinary piling quality, 60s.; ditto, good heavy forge of special quality, 70s. to 75s. per ton; all delivered works.

MACHINERY

(*continued from page* 24).

FOR SALE.—One No. 6 Thwaites Rapid Cupola, with drop bottom, complete with charging and cleaning doors in new condition, equal in every respect to new.—Price, £125, f.o.r., Keighley.

Two No. 6 Keith Blackman High Pressure Motor-driven Fans, complete with starters, etc, suitable for 400 volts, 50 periods, 65 amps., 12-in. delivery, 3-phase A.C.—Price, £125 each, f.o.r., Keighley.—Apply, Box 246, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—Harry H. Gardam & Company, Limited, Staines.

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—Stansell s Acetylene Company, Limited, Exeter.

PATENT.

ADVICE and Handbook Free.—Kinfi's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

OAK LOGS.—Buy now, at Lowest Summer Prices, from the Firm who makes them. Don't wait until the rush starts. Buy now. Price, f.o.r., 42s. 6d. per ton. Reduction on large orders. 500 tons in stock.—Baltic Saw Mills Company, Limited, English Timber Merchants, in all its branches, Tunbridge Wells.

THE

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Contents.

	PAGE
Foundry Technical Associations	207
British Electric Furnace Prospects	207
An Apprenticeship Course in Foundry Practice.—IX.	208
Gazette	210
Personal	210
Some Notes on Moulding Sands	211
Diminution of Lag at Ar1 through Deformation	216
Analysis Control in Acid Electric Steel Practice	217
Mr. McLain's European Visit	219
Electric Furnace Melting Costs	219
Roumania Wants Crucible Tool Steel	219
An Emergency Melting Plant	219
Pressure Trouble with Oil Cooler Castings	220
Austrian Iron and Steel Industry	221
Position in the Australian Iron and Steel Industry	222
American *versus* British Cast Iron	223
Molybdenum Steel Rolls	224
Sulphur in Cast Iron	224
Foundry Trade Technical Society	224
Production of Steel Castings	225
The Changes of Volume of Steels during Heat Treatment	226
Trade Talk	227
Company News	227
Deaths	227
Metal Markets	228

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Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

LIST OF SECRETARIES—

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Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.
London: V. C. Faulkner, 21, Stanley Gardens, W.11.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.
Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Technical Associations.

An announcement from Sheffield, appearing on another page, indicates that a second foundry technical association is to be formed locally. In the announcement the desirability of interesting foundrymen by talking to them in their own language is emphasised, and so is the necessity for including both iron and non-ferrous foundry work. Whilst we fail to find any difference in the objects of the new society and those of the Institution of British Foundrymen, we suggest that the former may be in a better position to discuss purely local problems; but this is difficult to imagine, as the Institution caters for the local conditions by the formation of branches.

Perhaps it is imagined that the national association does not try to cater for their artisan adherents. This is not the case, as is shown by the resolution carried at the last council meeting at Manchester, which decided against holding the 1923 Conference at Paris in order that the skilled moulder might not be prevented from taking part on account of expense.

Obviously, if local associations are to spring up in the great provincial towns the Institution must place itself on a higher plane, which the bestowing of a Royal Charter implies. The Institution must be the premier foundry technical association, and the suggestion arises whether co-operation could not be assured by making the President of the Sheffield Foundry Technical Society an *ex officio* member of the Council of the Institution of British Foundrymen, thus copying the relationship which exists between the Iron and Steel Institute and the Staffordshire Iron and Steel Institute, the West of Scotland Iron and Steel Institute, and other associations.

It is useless for the Institution to imagine that it will for all time be the sole representative of foundry technology, for it is now almost customary for the large provincial engineering societies to include at least one foundry paper in their session. This year the Iron and Steel Institute had presented before them an excellent paper on Foundry Sands. Such an occurrence as the formation of a second foundry technical society brings forward most clearly the necessity for a clear statement of the future policy of the national institution. If its work is to interest the moulder, the observation may be put forward that such lectures would not interest the foreman, manager, and owner. Financial considerations are also involved. If, on the other hand, programmes are so designed as to interest the foundry controlling staff, they might not be suitable for presentation to the moulder, coremaker, furnaceman and fettler. In the direction of instructing the foundry management, there is certainly adequate scope for the Institution, even if it is confined to sound technology, without catering for the higher branches of physical chemistry, which is more than adequately dealt with by other associations.

The Institution has done excellent work in the past and will do even better in the future. The formation of a second society is in a way a compliment, for all successful associations have had "offsprings." Still, we cannot help thinking that, taking into consideration the excellent work done by the Sheffield Branch of the Institution, that it is quite capable of adequately dealing with Sheffield's wants. The branches have much latitude, and can modify their programmes to meet local needs.

British Electric Furnace Prospects.

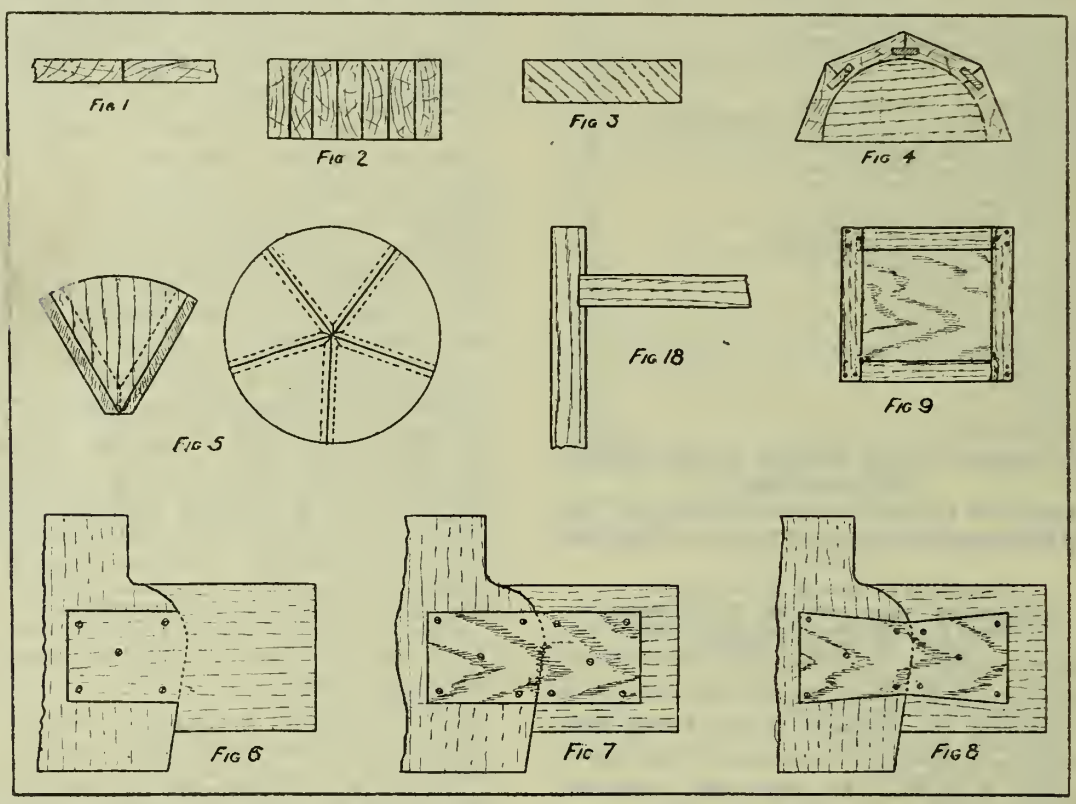
Electric steel, whether alloy or destined for castings, has suffered severely since the Armistice, the main factors being, apart from trade depression considerations, the too-rapid growth during the war period associated with the lack of supply of suitably-trained men, and in the case of the alloy-steel plants, the existence of large stocks of finished bars to be liquidated. The price of current has also seriously operated against extensive use. At the moment, however, interest is being re-awakened, and several old plants are being re-installed in fresh works. Additionally several plants are being restarted. Whilst it is advantageous to buy the latest design, it is still questionable whether high-powered furnaces give such satisfactory results as the older ones, in which the melter had to work hard to get the requisite heat.

An Apprenticeship Course in Foundry Practice—IX.

By Ben Shaw and James Edgar.

THE JOINTING OF TIMBER.

Different methods of jointing timber are adopted by carpenters, cabinetmakers, and patternmakers respectively, because of the different purposes for which the finished constructions are required, and the consequent necessary properties. The patternmaker may, and should, study elementary mechanics and graphic statics, but the knowledge will not be of value for mere woodworking, but because every patternmaker ought to be something of a designer, and in a great part an engineer; the carpenter, however, constructs with strength as the primary consideration. The cabinetmaker, on the other hand, is concerned with artistic effect, and sacrifices strength frequently to attain this. In patternmaking neither strength nor appearance are of much importance, as, consideration of how the work will deliver from the mould, and whether it will be adversely affected by the damp sand. It follows then, that, before alternative construction methods are dealt with, we must have a thorough understanding of the jointing of timber.



Face and Edge Joints.

When two faces of timber have to be jointed the first operation is to get one face as straight as possible by means of the trying plane, testing with straight edge and winding strips. It is very unsatisfactory to fit a piece of timber on a twisted face. Further, there should be no chalking of joints. Chalk may be used on a straight edge for marking, but if a whole surface is chalked, the powder fills the pores of the wood and prevents a strong glued joint being made. When two pieces of timber have to be jointed the ends should be examined in order that a "back to back" joint may be made, that is, a joint with the annual rings of the two pieces tangent. The glue should be thin rather than thick, and rubbed backwards and forwards two or three times till it grips. Dogs or cramps will hold the two pieces together, or it may be advisable to insert some screws. If a glued joint has been well made the joint will be almost indistinguishable when the glue is set. If it is not intended to protect the pattern with paint or varnish, glue should not be used in its construction at all; this is an important point that cannot be too well impressed on apprentices.

For nearly all flat work the plain butt joint is used for edge jointing (Fig. 1). The edges of the pieces must be squared from previously straightened faces, being held in the vice while being planed. It is possible to get a very good joint by simply glueing the two edges together and for some work there is no alternative; but it is more satisfactory to insert dowels in the joint. If, for instance, two pieces of 1-in. timber are to be joined ½-in. holes could be bored, care being taken when marking the centres, either with gauge and square, or, by using pins, and also when boring the holes, otherwise the plate may be badly twisted. Laying ordinary pins on a piece of timber and pressing the other piece on top of them gives an indentation to the head of the pin which can be used as a centre, but it is not as accurate a method as drawing the centre. The disadvantage of a dowelled joint is that the two glued edges cannot be rubbed. Further, if swelling or contraction takes place owing to the absorption of moisture or drying, the change in the measurement of the overall size of the plate may be so considerable as to spoil the pattern. It is therefore much better to leave the joint open. This localises alterations. Open joints should be about ⅛ in. wide, and thin slips of wood, called "slivers," are used to keep the pieces apart, while the dowels are being fitted. Some craftsmen nail and glue these slivers in position thereby betraying their ignorance of the object of open joints. The slivers should always be knocked out and this applies also when battens are screwed to the boards. Such wide boards are, in nearly all cases, the bases on which work is built and thus warping is prevented when the pattern is complete. A form of jointing up for thickness, which is now largely used, and is very satisfactory, is illustrated by Fig. 2. Say a large globe valve is required and blocks have to be built up, as the pattern is not sufficiently large to employ any kind of boxed up construction, there are two ways in which this may be done. Two or three thicknesses of timber may be jointed horizontally (Fig. 2), or 1¼ in. to 1½ in. timber may be jointed vertically. If well-seasoned timber is used, and the second method is employed, the joint will always remain straight. In shapes other than diameters the advantages are even more pronounced, one of these being that if unequal swelling of the different thicknesses does occur there can be no tearing of

the mould. Some patternmakers have so much confidence in joints of this kind that they simply clamp up the block and do not use screws at all, which is very unwise as glue is never altogether reliable.

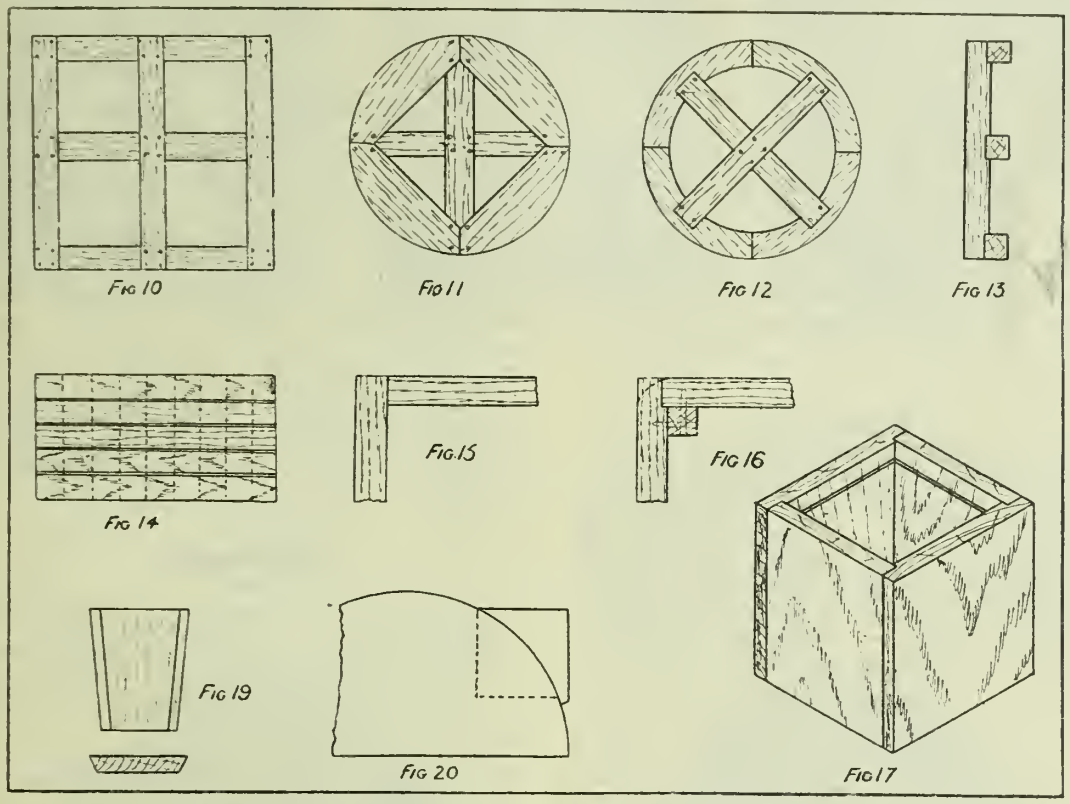
Tongue Joints.

Tongue joints are used in pattern-making, but invariably both edges are grooved, and a separate tongue inserted. It is not usual to tongue straight lengths. A much better joint is obtained, with less labour, when the tongue is a separate piece. The groove may be about ½ in. deep, and the grain of the tongue should be either quite cross or at an angle of 45 degs. with the sides, as in Fig. 3. If it is parallel with the side it does not give strength to the joint. It is common practice, when making large bushes, to make a shell pattern, staves being built on temporary grounds and separate tongues being fitted into the edges of the timber as shown at Fig. 4. The grooves can usually be sawn out at a circular saw, the edge having previously been planed to the correct bevel with the back faces. Fig. 5 illustrates another instance where tongueing is very satisfactory; it represents the plate centre of a wheel. Such a plate may be made by jointing parallel widths edge to edge and sawing to the diameter afterwards, but the method shown has the important advantage that any shrinkage that may take place is uniform around the circumference.

The most common use of tongues in pattern-making is for fastening branches to valves or pipes. Butt jointing for the purpose is never satisfactory, as the branches frequently move when the pattern is in the sand. It is not an easy matter inserting screws that will pull in the exact direction required and there is always the possibility of a moulder loosening a part off for making up and not screwing it back in the right position. A tongue obviates this danger; if it is well fitted it should be possible to unscrew a part and replace it accurately. Separate tongues of this kind should always be made of hard wood, preferably baywood, Figs. 6, 7, and 8, show three different forms of tongues. In the case of Fig. 6 the tongue is part of the branch, and considerable care and skill is necessary to make a good job, because the tongue cannot be planed to thickness. This is the most suitable method for comparatively small branches, Fig. 7 shows a parallel loose tongue, but the dovetailed tongue, as shown at Fig. 8, makes a very fine pattern, although it takes a little longer to fit. The groove or slots for branch tongues should be roughed out with gouges, and the bottom face afterwards planed with a router. If this is done and the tongue is planed parallel in thickness and square, the pattern face will be kept straight. When the tongue is separate from the branch it is advisable to fix the main body of the valve to a level board—the drawing-board is suitable—and make the branch a correct fit after which the groove for the tongue may be drawn and cut out.

The Half-lap Joint.

In almost all patternshops frames of one kind or another have to be made, and half-lapping is common. The patternmaker does not use the mortise and tenon joint at all. A half-lapped frame is much superior to an edge to edge plate for medium size and large work, Fig. 9 shows a simple frame with a filled in centre. It is not customary to fill in the spaces between the rails, because the moulder can usually stricklo these out, but in some cases it is necessary to do so, and a ledge is sawn or cut in the rails to give a "landing" for the filling-in piece. It is advisable to fill in all small frames, because it is really a simple matter, and a good surface is obtained for marking centre lines, etc. With regard to the width of rails much depends on the size of the frame, but they should be on an average from 4½ in. to 5½ in. wide, and the space between rails should not exceed 18 in.



A frame of large dimensions, with outside rails only, would be altogether too flimsy for most purposes, and quite useless for use as the base board of a large job.

In order to make a half-lap frame the rabbet plane and chisel are necessary to finish the work of the circular or band saw, unless there are facilities in the pattern-shop for cutting the half-laps to a finished line by machinery, and sufficient to be done to warrant the setting of the machine. If several rails are to have the same checks cut from them they ought to be clamped together and lines squared across all the edges at one operation. In Fig. 10, for instance, the upper rails should be clamped together, and the width of the checks marked, and the same would be done with lower rails. In gauging the thickness—the rails must have been planed parallel previously—the gauge ought to be set to half the thickness, but even when care is taken in setting the gauge, slight errors occur, and it is good practice to gauge from the backs of one set of rails and the fronts of the other set. Thus if a sharp rabbet plane is used when the frame is put together very little cleaning will be required. Apprentices usually leave too much for finishing owing to lack of confidence. For thickness 1-16 in. is ample for cleaning both sides and not more than ⅛ in. across the widths. Screws should always be used for fastening the rails, although when the frame is very thin lead

rivets are to be preferred. Unskilful workmen often find when they have screwed a frame together that it is badly twisted, and this is the result of not planing the various laps parallel. It is very nearly impossible to get a frame right that has been made out of truth. The centre rail of half-lap frames should always be easy fitting because they may swell when in the sand, and if tight they will probably twist the frame.

Sometimes a circular plate is made of a half-lapped cross and segments let in as shown in Fig. 11, but this is not as good as making a segmental ring in two or more courses, and setting in the cross, as in Fig. 12. When making frames the inside positions of the rails have very often to be determined by the positions of ribs, facings, and branches, otherwise special rails may afterwards have to be fitted, which can seldom be done satisfactorily. The width of rails also depends to some extent on the details that will be fastened to it. With regard to thickness of construction frames, that is frames that are used for the inside of a boxedup pattern, no definite size can be given as much depends on the size of the work. Such frames should certainly not be less than 1¼ in. however. and should preferably be 1½ in. Construction frames like these are not always made as ordinary half-lap frames, but instead ½-checks are taken out of the vertical rails and into these the horizontal rails are set, as in Fig. 13.

An alternative to the half-lap frame for large plates is the method of crossing boards, as in Fig. 14. If a plate is required 8 or 9 ft. square, and say, ⅝-in. thick, it is impossible to make a very [illegible]g half-lap frame, and so the crossing of 5-16 [illegible]ards is almost a necessity, but it is not to b[illegible]mmended when a half-lap frame can be mad[illegible]e edge, even when open joints have been left [illegible] become irregular owing to side and end gra[illegible]g on the same face, and the edges of the boa[illegible]rl up; this necessitates the moulder doctoring [illegible] face of the mould, with the result that metal ⅛ in. or more thicker than is required may be obtained.

Corner Joints.

Not many different kinds of corner joints are made in pattern-making. There is seldom, if ever, any excuse for joining corners with a plain butt joint, as in Fig. 15. It is not much, if any, quicker than a housed joint, and inside ends almost inevitably get knocked in before the pattern has been long in use. The housed joint, shown in Fig. 16, is almost as quickly made, and is, in every way, satisfactory. When the corner has to be rounded, as indicated by dotted lines, a square block may be fitted on the inner corner to hold the ends and sides together. A typical form of construction is illustrated by Fig. 17. The sides are recessed into each other, as above described, and the top is "let in" and rests on recesses sawn from the sides. This is an ideal form of construction for the foundry, because the edges of the top—bottom when it is in the mould—cannot tear the sand when it is being withdrawn.

The usual form of corner joint for core-boxes is shown in Fig. 18. This is not adopted for appearance, as one manual the authors read some time ago explained, because appearance does not matter with core-boxes, but because it has been found to be the most suitable joint for maintaining accuracy. A plain butt joint is frequently used for large core-boxes, which is quite good, because of the constructional method employed, a matter we shall go into when discussing core-boxes. The sides of core-boxes should be at least 1½ in. longer than the housings for the ends which need not be more than ¼ in. deep.

Patternmakers' Dovetails.

With the ordinary carpenters' and cabinetmakers' dovetails the patternmaker has no concern, one reason being that accuracy cannot be guaranteed. At the same time the dovetail is much used in pattern-making, especially for fine and for standard work. When making gears the teeth are sometimes fastened to the rims with dovetails, but the most general use for them is for loose pieces. Unlike carpenters' dovetails they are tapered, as in Fig. 19, and must be made a close fit, and yet be easily withdrawn. They are invaluable for fastening facings, and bosses on vertical sides, and are usually about ¼ in. or ⅜ in. thick. At Fig. 20 a dovetail is shown as a method of holding a circular boss in position.

The Paper Joint.

The paper joint cannot be called a pattern-making joint exactly, because it is only used as a temporary expedient. It may be convenient when making small work on which there is a lot of carving to make up the body of a pattern in several pieces yet very inconvenient to screw these pieces together. If thin sheets of paper—newspaper answers the purpose—are glued and inserted, the blocks can be planed and marked off after which a chisel may be inserted at the edge when the joint will part by splitting the paper. The paper joint is sometimes used for fastening delicate work to the lathe chuck for turning.

Gazette.

The public examination of C. W. Buttle, engineer, Birmingham, took place on August 7. The liabilities were £249.

Mr. C. Starkey, 67, Knutsford Road, and 38, Barbauld Street, Warrington, iron, steel and metal merchant, has been adjudicated a bankrupt.

It has been resolved that the Putney Founders, Limited, be wound up voluntarily. Mr. H. H. Jeffries, 53, Peterborough Road, Hurlingham, S.W., has been appointed liquidator.

Mr. A. F. Webster, Denbigh House, 13, Stanley Road, Teddington, engineer, has been adjudicated bankrupt. Examination, County Court, Kingston, October 10, at 2.30. Adjudicated, September 2.

The partnership heretofore subsisting between Messrs. W. Pearson, G. E. Jones, E. Heginbotham and O. Heginbotham, engineers, machinists, etc., High Street, Stalybridge, under the style of E. Heginbotham & Brother, has been dissolved.

The creditors of the Rennie Ritchie and Newport Shipbuilding Company, Limited, who met last week, decided to apply to the Court for a supervision order and to appoint a committee to represent the unsecured creditors and shareholders. The company's gross liabilities are put at £94,279, of which £43,551 is expected to rank, while the assets, after allowing for £39,169 secured on first mortgage debentures, are estimated at £103,543, or a surplus of assets of £59,992.

Personal.

The late Mr. J. E. Renshaw, of Derby House, Mill Mead, Staines, ironfounder, left £1,895.

Mr. W. F. Ireland has been appointed Inspector of Factories in charge of the Wolverhampton district.

The late Mr. David Bevan, a director of the Grovesend Steel and Tinplate Company, Limited, left £24,088.

Mr. G. Allin has been appointed works manager of Ley's Malleable Casting Company, Limited, of Osmaston Road, Derby.

Professor Granville Poole, of Leeds University, has been elected neutral chairman of the Cumberland Iron Ore Mining Conciliation Board.

The late Mr. E. Windsor Richards, J.P., D.L., the well-known Welsh ironmaster, left gross estate of the value of £87,811, with net personalty of £77,898.

Mr. W. D'Arcy Madden, formerly general manager of Hick, Hargreaves & Company, Limited, Soho Ironworks, Bolton, has been elected managing director of the firm.

Mr. W. A. Stanier, previously manager of the G.W.R. locomotive works at Swindon, has been appointed works assistant to the chief mechanical engineer.

The late Mr. A. C. Wells, a director of the Unbreakable Pulley & Mill Gearing Company, Limited, left estate of the gross value of £82,327, with net personalty £68,034.

T. W. Greenwell & Company, Limited, engineers and ship repairers, of Sunderland, have placed a contract with Sir William Arrol & Company, Limited, of Glasgow, in connection with the provision of the new dry dock which is to be constructed adjoining the South Dock. The new dock will be 500 ft. long, 75 ft. broad at the entrance, with a depth of 26 ft. at H.W.O.S.T., and will be considerably larger than any existing dry dock on the Wear. The contract is for the construction of the dock entrance and 500 ft. of quay. Messrs. Greenwell are also having erected spacious new shops to meet the needs of their repairing work.

Some Notes on Moulding Sands.*

By J. H. Watson.

The importance of suitable moulding sand as a contributory factor in the production of good castings will be readily admitted by all who profess to have experience of the manufacturing side of the foundry business.

Although greater attention is being given to coke, pig-iron, scrap, and scientific cupola control, little is heard about the quality and suitability of the moulding sands which swell the total of the annual cost of raw materials.

One fact remains clear, however, and that is the general to-day, and, in many cases, modifications and improvements in the treatment of sand in the foundry are necessary.

Early Post-War Experiences.

It is necessary to point out that while these experiences refer chiefly to the production of green-sand repetition work in very large quantities, nevertheless there are general principles involved which apply to sand used for any class of moulding.

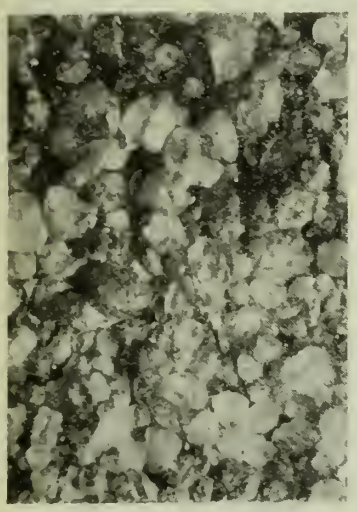


Fig. 1.—Belgian High Silica Sand.

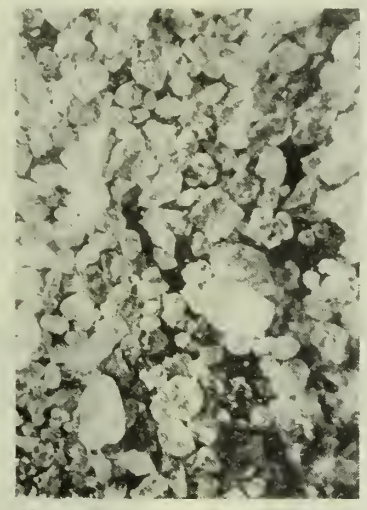


Fig. 2.—British High Silica Sand.

Fig. 3.—French High Silica Sand (Silver).

casualty list of waster castings—due either to unsuitable sand or badly misused sand—is heavy enough to warrant an attempt at its reduction.

All foundrymen desire a perfect sand, but, unfortunately, it does not exist. They very often have to make the best use of what they have been accustomed to use for many years. Do they always make the best use of British moulding sand supplies? This is very questionable, and the writer's endeavour is, if possible, to arouse interest in this direction.

It has been the author's experience, along with others, to have had periods during which the production of nice, clean-skinned castings left nothing to be desired; and when the percentage of wasters through such causes as "drops," "scabs," etc., were at a happy minimum. Then there are periods when nothing seems to go right; the sand is wrong, the metal too hot or too dull; moulding not as it should be—in short, there are quite sufficient reasons to allow of one having a generous diversity of choice.

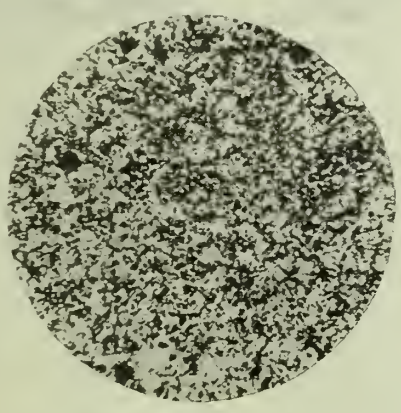


Fig. 4.—Erith Loam (Strong). Transmitted Light × 8.

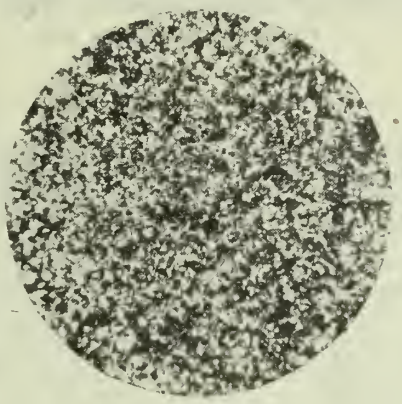


Fig. 5.—Erith Loam (Medium). Transmitted Light × 8.

Both Have Been Reduced Slightly on Reproduction.

Broadly speaking, foundrymen desire a sand which, after the exercise of normal moulding skill, will give (1) a clean impression of the pattern; (2) withstand flow of molten metal until mould is filled; (3) strip freely and leave a clean, accurate casting. These requirements sound simple, but to attain such results in actual practice and with some degree of regularity calls for a deeper knowledge of the properties of moulding sand than is

The remedying of most foundry troubles resolves itself largely into a question of elimination, and with this in mind the writer decided to prove or disprove, if possible, any accusations directed against the sands in use. Seeing that moulding sand is the initial raw material used in the production of the finished article, it was considered this should be a legitimate object for first consideration.

During the period subsequent to the Armistice the author was using red sand from How Mill and rotten rock sand from Boldon. The latter appeared

* A Paper presented before the Newcastle Branch of the Institution of British Foundrymen.

good for cores, but did not appear to be sufficiently strong or refractory for the then current moulding purposes, which was an output of repetition green-sand castings amounting to 400 or 500 tons per week. The How Mill sand did not appear sufficiently refractory. It contains a considerable amount of mica in small, thin flakes.

Later it was possible to obtain supplies of Erith loam, which was previously in general use throughout the whole of the works, and an improvement of skin was visible. However, scabbing and dropped tops were sufficiently frequent to cause worry, and the skin of the castings was not consistently good.

The mixing of sand for ordinary jobbing work was left partly to the moulders and partly done by labourers; but as regards the repetition work foundries mixing was carried out by labourers solely.

Use and Abuse of a Good Sand.

When using Erith loam it was noticed that some days the castings had a very good skin, other days the skin was poor. Apparently with the same sand it was possible to get good or bad results.

After investigation it was decided that the system of mixing the sand could be improved. Definite quantities of burnt sand, fresh loam, and coal dust were mixed, milled and riddled before being passed to the foundry. Some attempt was made to control the amount of water used in tempering the sand. A new and improved impact coal grinder was installed, which gave an abundant supply of finely ground coal.

The net result of this change was a decided improvement in the skin of the castings, which has been consistently maintained.

The point so far is that with an admittedly good sand, such as Erith loam, the best results had not been obtained owing to imperfections in the system of mixing. Before condemning any sand it is advisable to pause and consider whether we are giving it an opportunity to function at its best. On the other hand, it is just as well to realise that all sands have their limitations as regards use for any and every class of work.

Having obtained an improvement by altering certain methods of treating the sand, the next step was to discover *why* such a change in treatment gave better results. This will be shown later.

Origin of Sand and Typical Composition.

The geologist assures us that the origin of all sand may be traced to the granitic rocks forming the earth's crust after solidification took place. Granite is composed of the following minerals:—Quartz crystals, 50 to 60 per cent.; felspar, 30 to 40 per cent.; mica, about 10 per cent.; and frequently traces of iron. Quartz is, of course, pure silica, SiO_2; felspar is made up of orthoclase ($K_2O.Al_2O_3.2SiO_2$) and anorthite ($CaO.Al_2O_3.2SiO_2$); and mica is mainly $KNa.H_2.Al_2(SiO_4)$.

During the immense periods of time subsequent to solidification the granite has been broken down into its constituent minerals by natural agencies. The quartz crystals, though altered in shape and size, remain unchanged as regards composition.

Part of the mica and felspar also remain unchanged chemically, whilst a portion decomposes into simpler compounds containing lime, soda, potash, alumina, and silica.

Moulding sand may be defined as a substance consisting essentially of grains of quartz, varying in size from coarse to exceedingly fine, and in shape from rounded to angular, associated with a very fine clayey material (pure china-clay—$Al_2O_3.2SiO_2.2H_2O$) and hydrated oxide of iron (limonite—$2Fe_2O_3.3H_2O$): also mineral particles containing lime, soda, and potash.

The particular use to which the sand may be put depends upon the relative proportions of these three classes of mineral ingredient. High silica sand is composed almost entirely of quartz grains. The absence of clayey material renders necessary some artificial bonding material before it can be used for moulding purposes.

The amount of clayey material and oxide of iron (*i.e.*, bonding materials) accounts for such differences in strength as mild, medium, and strong varieties of loam. Size of grain has also an influence on strength.

If the minerals responsible for lime, soda, potash, which exercise a fluxing influence, are present in excessive quantity, its refractoriness is reduced, and a tendency to stick to castings of thick section may be observed. This, however, can be greatly minimised by the use of a suitable refractory facing.

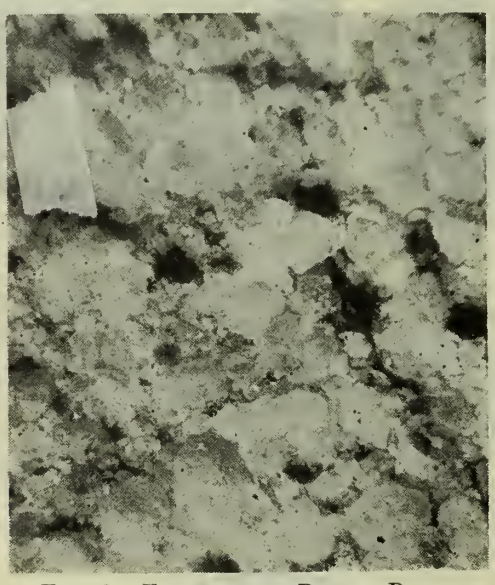


Fig. 6.—Fragment of Rotten Rock.

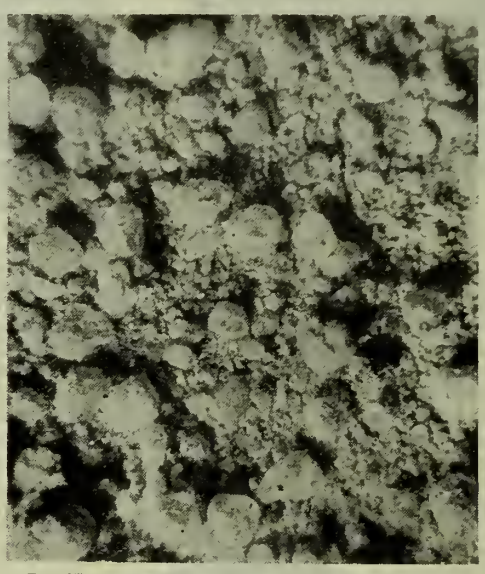


Fig. 7.—Fragment of Rotten Rock (Crumbled).

For purpose of comparison, the analyses of a naturally bonded moulded sand and a high silica sand are given below:—

Hutton's Ambo No. 3. Erith quality.

	Per cent.	
SiO_2	86.8	
Al_2O_3	6.45	
Fe_2O_3	1.55	
CaO	0.45	2.11
K_2O	1.5	
MgO	0.16	
TiO_2	0.197	
Loss on ignition	1.7	

Hutton's Ambo No. 15. High Silica.

	Per cent.	
SiO_2	95.7	
Al_2O_3	1.7	
Fe_2O_3	0.35	
CuO	0.10	0.96
K_2O	0.60	
Na_2O	0.10	
MgO	0.16	
H_2O (above 105° C.)	0.80	

Essential Properties.

The chief properties which enable a sand to function successfully are as follows:—(1) Refractoriness; (2) venting qualities; (3) strength of bond; (4) size of grain.

Refractoriness.

From the view-point solely of resistance to high temperature, the higher the percentage of quartz grains, *i.e.*, silica grains not in chemical combination with any other mineral, the more refractory the sand. This is accounted for by the fact that the melting point of quartz is about 1,700 deg. C. (U.S.A. Bureau of Standards), which is considerably above the casting temperature of cupola-melted iron. (Hot iron is at the temperature of 1,350 deg. C according to Hatfield).

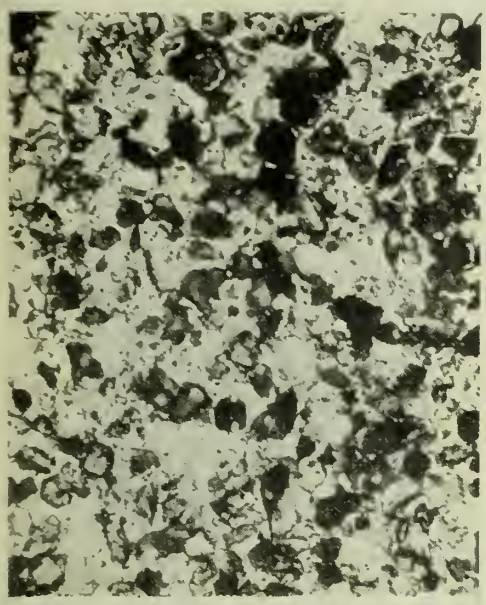


Fig. 8.—Erith Loam (Strong) × 35. (Transmitted Light.)

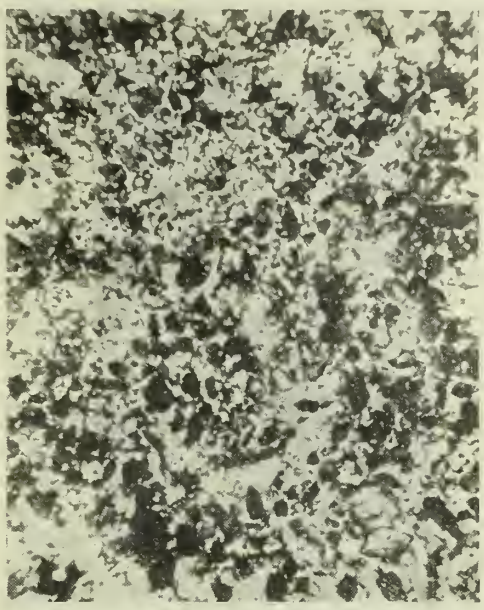


Fig. 9.—Erith Loam (Medium) × 35. (Transmitted Light.)

Both Have Been Reduced Slightly on Reproduction.

There is a common impression that a sand showing on analysis a reasonably high-silica content will be refractory sand. Though silica is the commonest constituent of rocks, it is most frequently in chemical combination with other substances, *e.g.*, lime, magnesia, soda, potash, etc., and, combined in this way and forming as it does a mineral ingredient of moulding sand, it does not possess the same degree of refractoriness as when in the free or uncombined condition—*i.e.*, when it is present as quartz. Hence, if such minerals as felspar and mica, which contain silica combined with lime, soda, and potash, are present to any great extent, the heat-resisting qualities of the sand will be lowered accordingly.

Chemical analysis may not be possible to all who may desire to attempt in a modest way to investigate the sands they are using. If not, there is no need to be disheartened. Apart from chemical analysis, the use of a good hand lens, or, better still, a microscope is a very great aid in the detection of quartz grains, and some of the commoner minerals such as felspar and mica.

This latter instrument need not possess research qualifications. The author has spent many interesting and profitable hours with an instrument which cost only 50s.—post-war price.

This is mentioned by way of comfort to any foundryman who may be inclined to wilt at the mention of a microscope.

The remarks made regarding free silica (quartz) and silica in combination with other substances and the effect upon the refractory quality of the sand, apply also to the clayey matter present. Pure clay (Al_2O_3, $2Si_1O_2$, $2H_2O$) softens about 1,740 deg. C. (U.S.A. Bureau of Standards), but the softening point may be considerably lowered by the presence of such fluxes as lime, potash, etc.

The simplest illustration of the lowering of individual refractory capacity is to be found in ordinary cupola working, where lime, with an individual melting point of 2,570 deg. C. and sand, ash, etc., with a melting point of, say, approximately 1,700 deg. C., form a fusible fluid clay at normal temperatures, the highest of which, even on extremely hot metal days, falls considerably below the melting point of sand, *i.e.*, the material with the lower melting point of the two.

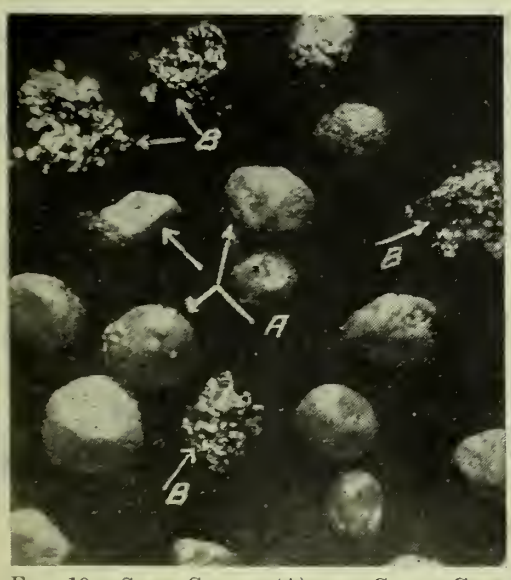


Fig. 10.—Sand Grains (A) and Coked Coal-Dust Particles (B) from Mould Face.

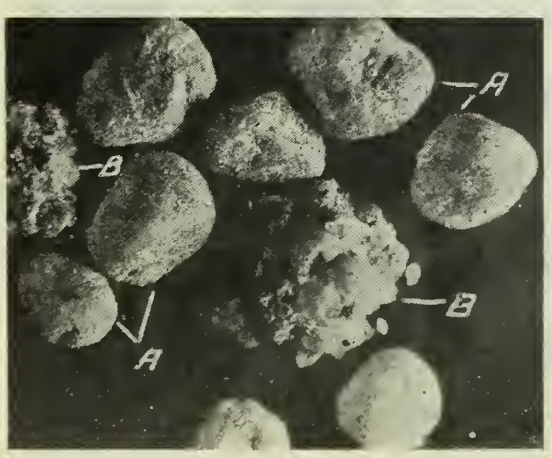


Fig. 11.—Sand Grains Coated with Clayey Matter (A) and Conglomerate Particles (B).

While the temperature of molten cast iron makes no such severe demands upon a sand as molten steel, frequently castings of heavy section have the sand "burnt on." This is very likely to happen where "hot" metal is the practice—and where is it *not?*—even when the section is not particularly heavy. The advantage of using a suitable artificial refractory facing becomes apparent in such cases.

The true reason for using graphite, plumbago, blacking, etc., as a mould facing is to render the sand particles more refractory by coating their surface with highly refractory material. This protective casting largely eliminates burning on of the sand, and produces a good skin. An actual

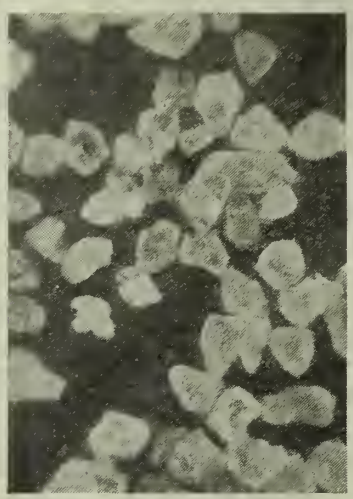


Fig. 12.—Angular Grain.

trial of two moulds, one with and one without such protective facing, and using fairly hot metal, will furnish proof of a very conclusive nature. Coal dust functions in a similar manner as regards its part in producing a skin.

If a portion of a mould made of sand, to which coal dust has been added, be examined after stripping from a casting, the surface of the mould and the individual sand grains are found to be coated with a very fine shiny deposit of carbon. This deposit makes the grains of sand more refractory, and assists very greatly in obtaining clean stripping and a good skin. Too much coal dust weakens the strength of a sand, and is liable to produce sand cracks, which leave a veined marking on the castings.

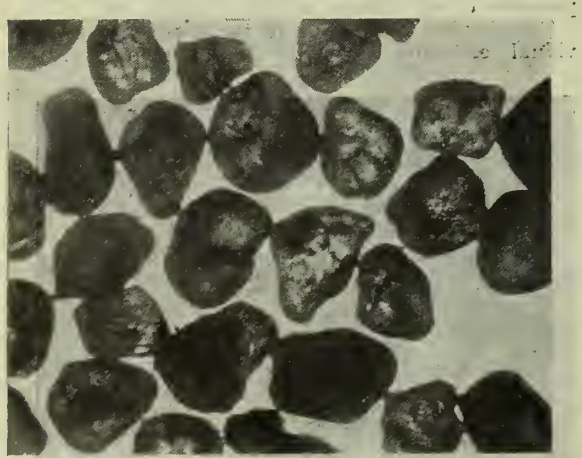


Fig. 14.—Grain Size 1/400-in. Maximum. 50 per cent. of this Type Present.

In the event of a coal shortage it may be necessary to obtain a substitute for coal. Creosote oil, ground pitch and tar are very satisfactory so far as producing a skin is concerned, but the fumes are dense. Sawdust is a cheap substitute, but the quantity required interferes seriously with strength of mould.

Venting Qualities.

However hard rammed and closely packed together sand grains may appear to the unaided eye, there is an appreciable space area remaining.

To better illustrate this, suppose thirty-six half-pennies to be laid down into a 6 in. square; they could not be packed any closer unless made to overlap each other.

The actual area covered by the coins represents, in round figures, 80 per cent. of the total, and the balance of 20 per cent. may be termed "open space." Making allowance for the fact that sand grains are not flat discs like coins, but may vary from spherical to angular shape, it is evident that a certain amount of space area will be available by means of which it will be possible for the mould to vent itself naturally.

This natural venting capability will depend upon (1) the type of grain, whether rounded or

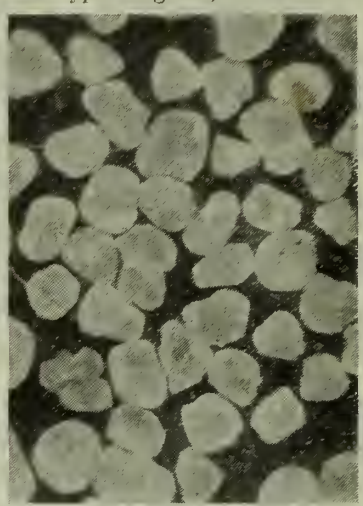


Fig. 13.—Rounded Grain.

angular, also whether the prevailing grade be course, medium or fine; (2) the amount of clayey matter and excessively fine particles present in all naturally bonded moulding sands; (3) the amount of water used to temper the sand.

Broadly speaking, the coarser the grain the better the venting quality of the sand. At the same time, it must not be forgotten that if there is a large amount of clayey material and fine silt present this small stuff will fill up part of the space area of the mould and diminish its venting capabilities. Too much water in the sand has a similar influence, and this added defect, *viz.*, excessive generation of steam, thereby further taxing the venting capability of the mould.

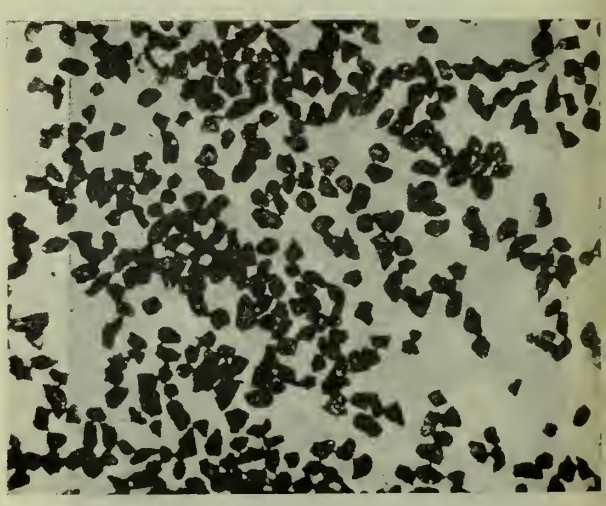


Fig. 15.—Grain Size 1/200-in. Maximum.

While dealing with the question of venting qualities, the following experience may be of interest:—Troubles from scabbing arose amongst a certain type of casting which is produced in large quantities. If the mould was rammed hard scabbing was very prevalent. On the other hand, if slack ramming was resorted to, the castings gauged very badly. The gauging allowances were not too generous, and the difficulty was further accentuated by the fact that their manufacture was carried on by semi-skilled labour.

By reducing, and in some cases eliminating, Erith loam, and using a coarser grade of sand, the foundry was enabled to reduce scabbing to a minimum, and also obtained much greater latitude as regards individual variations in ramming; in fact, instructions were issued to ram the moulds fairly hard. The gauging also was very greatly improved. The change was made by introducing Hutton Ambo sand at first, but later we obtained a much cheaper and quite satisfactory sand from Boldon, Co. Durham.

Strength of Bond.

What the bonding quality of a sand really means from the view-point of practical utility is best realised by considering how the millions of particles in a green-sand mould adhere to each other and retain the pattern outline after the support of the pattern is withdrawn.

A high silica sand or sea sand will, after being wetted, retain simple shapes, *e.g.*, the sand pies of seashore fame, but such shapes will hardly bear touching without collapse. The peculiar property of a moulding sand is due to other than a mere wetting of the grains. Oxide of iron and the clayey matter present in the sand possess the property of absorbing water, and by so doing become sticky or possessed of adhesiveness. Usually the sand grains are coated with a thin film of oxide of iron and also clayey matter which, on moistening with water, enables the grains to hold together much more tenaciously than is possible in the case of a moist high silica sand, where the very slight adhesiveness is due only to the surface tension of the water.

The amount of water which may be added to temper a sand correctly varies considerably with different sands. It is not, however, a difficult matter to determine the most suitable proportion for any sand which may be in use, and well worth a little trouble, for instructions can be given as to quantity required with each mixing, and the frequently misplaced generosity of some individual with a bucket or hosepipe be curtailed.

After a batch of moulding sand has been moistened by a suitable addition of water, such operations as mixing, riddling, and milling are found to strengthen the sand considerably. By such processes, the bonding materials present are well distributed throughout the bulk of the sand and the grains become more thoroughly coated with such adhesive material. The tempering water is also much more uniformly distributed if these operations are thoroughly performed.

In certain cases, a sand which apparently possesses a low degree of bond strength can be made stronger to a surprising degree by thorough milling. This is due largely to the distribution effect previously mentioned, and also to the breaking down of small knotty masses about the size of very coarse grains, and which are in reality composed of a number of fine grains bound together like fragments of sandstone rock.

Grain Size.

Messrs. Hanley and Simonds, in *The Foundry* of Sept. 15, 1920, rightly emphasise the importance of grain size in relation to the amount of bonding material present. "The strength of bond is influenced by the surface area of the sand." That is to say: it does not inevitably follow that in two moulding sand samples, the former containing a higher percentage of bonding material than the latter, that the first will have the greater bond. Grain size must be considered. A small grained sand has a bigger total surface area than a coarse-grained variety. If, therefore, that with the smaller grain contains a higher percentage of bonding substance, it must be remembered that it has to be spread over a larger surface.

A further point to be considered in respect of grain size is the fineness of skin required on the casting. A coarse sand may be used on castings which are not required with a good skin, pig iron for example. For fine work, naturally a fine smooth sand is required, and this applies particularly to the making of metal patterns. The venting and bonding properties must, however, be kept in the foreground if consistent results are desired.

In conclusion, the functions of a good moulding sand can be summarised as follows:—

1. To retain a clean impression of the pattern. (a) It is necessary to have the requisite natural bonding materials present and make full use of this property of the sand by correct proportioning of water and suitable mixing, milling and riddling. (b) Choose a sand having a grain that will leave a smooth clean mould skin.

2. To withstand flow of metal until mould is full. (a) A sand is required that will stand good sound ramming without packing so close as to fail to carry off gases and steam. (b) Possess sufficient strength of bond to prevent peeling, cracking, washing, buckling, etc.

3. To strip freely and leave a clean casting. By suitably coating the grains of sand with an artificial refractory so as to assist or augment the natural refractoriness of the sand in immediate contact with the molten metal, and prevent burning on of sand particles.

DISCUSSION.

Mr. Young, in opening the discussion, said Mr. Watson had mentioned that his Paper was elementary. Mr. Watson had had a great deal to do with sand, and where real "experience" is concerned the word "elementary" did not apply.

Mr. Wise said he thought that the moulding quality of a sand could only be found out by actual practice in the shop, but as regards the quality, the chemical analysis could be a great help to the average foundryman. He wished Mr. Watson had spoken about oil-bonds as well as clay-bonds, as a great many difficulties could be eliminated by the use of oil-bonded sand.

Mr. Gallon said that in green-sand moulding it was very essential to mix the sand with a certain amount of coal dust, and he would like Mr. Watson to give the amounts of coal dust in the particular sands, and also the results of adding such quantities. One could take a handful of sand and squeeze it together, and by looking at it tell whether it was a good moulding sand or not, but one could not tell how much coal dust it contained. If the quantities of coal dust and blacking were given they would be helpful to men who have not had a chemical education.

Mr. Frier asked whether the lecturer was in favour of the Erith loam. He thought that in foundries where green-sand and dry-sand work had to be carried out close together it was best not to have too many kinds of sand.

Mr. Oakford asked whether it was possible, when making large quantities of repetition castings, to avoid the use of facing sands. Concerning the question of sand-treatment, there are many expensive ways of dealing with the sand, but we needed to find a method of dealing with it cheaply in large quantities. He considered more of the old sand in foundries should be thrown away and replaced by new sand, the latter being cheaper than defective castings.

Mr. C. Gresty asked what were the relative advantages and disadvantages of naturally bonded sands and artificially bonded sands.

Mr. Young said that the lecturer had brought up the question of sand of different sized mesh, but did not mention what sizes. He would also like to know whether Mr. Watson had found that coals with different ash-content gave different results. He considered the adherence to one particular type of foundry sand was largely due to lack of knowledge, and if people had a good look round they might find some cheaper and, perhaps, better.

The Author's Reply

Replying to Mr. Wise, the lecturer said it was profitable for all to make their own tests, and if a foundryman had found a good sand he advised him to keep to it. It was quite a simple matter to find out the grain of a particular sand by the use of a set of sieves. He had confined his remarks to the sands which he had had the most experience with.

With regard to the quantity of coal dust used, Mr. Watson said that the idea of his Paper had been to give the lines on which he himself had worked. When one had a sand which gave good results, the next thing to do was to look round and see if there was a cheaper sand which would give equally good results. If a fine skin was wanted on a casting the quantity of coal dust

would have to be increased. The job had to be considered before the amount of coal dust could be fixed, but by all means work with a minimum.

He did not pin his faith to any particular sand, but rather chose one which could be obtained without unnecessary railway expenses. It is preferable to work with only one or two types of foundry sand.

He (Mr. Watson) advised Mr. Oakford to try the repetition work without the use of facing sands, but the results would not be so successful, and one has to consider reputation as well as expense. The handling of sand can be done cheaper by hand in certain cases, but for large production work it is best to have some kind of mechanical arrangement.

It is often essential to add fireclay to sand on account of the sand being too refractory, but it is advisable to use a naturally bonded sand when possible, because it will work out cheaper.

If a coal high in ash and slatey material is used the castings are inclined to look rather grey, and where there is only a few shillings per ton difference between two coals it pays to get the better one, as a much better skin can be obtained on the castings.

A hearty vote of thanks was then given to Mr. Watson for his lecture, and also to Mr. Patterson for the permission accorded to Mr. Watson to publish the information obtained at his works.

Diminution of Lag at Arl through Deformation.*

By J. H. Whiteley.

(*Abstract.*)

Evidence of lag in the crystallisation of pearlite, particularly in hypo-eutectoid steels, is derived from several considerations. It is found in the well-known fact that, for a given steel, the temperature of the Arl transformation is not constant but is lowered as the rate of cooling is increased. Again, since the presence of carbide nuclei within the γ-iron areas induces crystallisation of the carbide and ferrite as globular pearlite at a temperature considerably higher than that at which growth takes place in the absence of such nuclei, lag must clearly occur in the latter case. In the experiments described below, two methods of deformation were used, namely, hammering and bending.

A small electric furnace, containing a silica tube 1 in. internal diameter, wound with nichrome wire, was placed vertically on a block of steel, resting upon two supports. A bar of hard chrome steel, ½ in. square section, was used as an anvil, and between it and the block was a thick pad of asbestos board. A thermo-couple, passed through a hole drilled in the block, was so placed that the temperature of the furnace at the surface of the anvil was recorded. A rod of manganese steel was used to transmit the hammer-blows to the specimen on the anvil.

(1) *Deformation by Hammering.*—In this experiment the steel consisted of a piece of ordinary mild-steel plate which had been allowed to cool in the centre of a solidifying slag ball; the normal banded structure was thus eliminated and an approximate uniformity in composition obtained. The Arl point had previously been found, by quenching specimens, to lie between 685 and 690 deg. C., and Ac1 between 715 and 720 deg. C. Two small sections, differing in shape so as to be easily distinguished, each weighing about 1.0 gramme, were placed on the anvil, and the rod placed on the adjacent asbestos packing. The temperature was raised to 900 deg. C., and then lowered in about ten minutes to 695 deg. C. After the pieces had remained at this temperature for fifteen minutes, in order to give time for equilibrium conditions to be established, the rod was carefully placed on one of them and a smart blow given with a hammer. During the next ten minutes the temperature was kept at 695 deg. C. and the above procedure repeated, in varying order, about six times, and after a further five minutes the specimens were rapidly quenched in water. The deformation made by hammering in this way was found to be comparatively small; the same experiment was done several times, and in no instance was the depth of the piece (3-16 in.) reduced more than 1-40 in.

The results obtained from the repeated experiments all agreed. They showed unmistakably that lag at Arl could be diminished by slight deformation.

(2) *Deformation by Bending.*—The same apparatus was used in this experiment. In order to bend the specimens a V-shaped notch ⅛ in. deep was cut in the top of the anvil, and the end of the rod shaped like a chisel. A strip ½ in. by 3-16 in. of steel sheet, 1-16 in. thick, of similar composition to the steel used previously, was placed across the notch, heated to 900 deg. C., and cooled to 695 deg. C. When the piece had remained at 695 deg. C. for fifteen minutes, the rod was placed upon it so that the end was in line with the notch and two or three light blows were then given with a hammer. The strip was bent in this way through an angle of about 60 deg. After a further five minutes at 695 deg. C., the piece was taken out and rapidly quenched. At the bend, pearlite was always present, but in the limbs, where the metal had been distorted, the structure consisted almost entirely of ferrite and martensite.

A similar, but less pronounced effect, was produced when strips were bent at 700 deg. C.; pearlite was present only at the bends, about one-fourth of the austenite having crystallised. The first results obtained by hammering only were therefore fully corroborated in these bend tests. They show that lag at Arl can be appreciably diminished through deformation.

It should be noted that although lag was reduced it was not completely eliminated by the methods of deformation used, for in a previous investigation with the same steel globular pearlite was found to grow between 705 and 708 deg. C., when carbide nuclei were present in the austenite. Possibly, if the metal could be sufficiently distorted, lag in the formation of lamellar pearlite would be equally diminished.

In conclusion, it may also be mentioned that since a certain amount of lag also occurs at the Ar3 point, a few similar experiments were made in order to ascertain whether this supercooling could likewise be reduced by deformation. Strips were heated to 900 deg. C., cooled to temperatures a little below Ar3, and then bent. Here, however, the separation of free ferrite from the solid solution did not appear to be accelerated by the deformation produced in this way.

* A Paper read before the York meeting of the Iron and Steel Institute.

We are sorry to announce that Mr. Matt Riddell, past president of the Institution of British Foundrymen, is at present quite unable to attend to business through ill-health. We trust that he will soon be restored to health.

London Foundrymen will be pleased to learn that the Sir John Cass Technical Institute is organising foundry classes on a more important scale during the coming session. Mr. Wesley Lambert, president of the London Branch of the Institution of British Foundrymen, is giving a substantial prize, and Mr. J. Ellis, a past-president of the Institution, is to be examiner for this purpose.

HYDRO-ELECTRIC DEVELOPMENT IN INDIA.—Sir Ganga Ram, C.I.E., M.V.O., who is at present in this country, has placed an important order with Vickers, Limited, for water turbines and electrical plant, in connection with the development of power from a low head fall on the Bari Doab Canal in the Punjab. The head which will be utilised is only 6 ft., and the total power obtained will be 1,925 h.p. The energy will be transmitted to various pumping stations, where irrigation water will be raised, thereby enabling larger areas of good land to be cultivated. The extreme low head makes the proposition an exceedingly interesting one from a hydraulic point of view, and it is pleasing to note that British manufacturers are now in a position to carry out such projects.

Analysis Control in Acid Electric Steel Practice.*

By A. C. Jones, Chicago.

(*Slightly Abridged.*)

Too Many Changes in Practice Costly.

In making steel many foundrymen change the melting practice too often. When trouble occurs with the castings, which may or may not be due to the metal, a change is thought necessary which possibly means a more expensive practice. Then when everything goes smoothly as far as the quality of metal and even operation are concerned, an effort is made to cut down on the expense in some way. This brings further changes which sometimes are converted into more trouble. A change in practice should not be made once this phase has been carefully and thoughtfully adopted unless there is a strong reason for it.

Sometimes there is a tendency to start out with a fine programme and to gradually change it little by little. After fairly good results have been obtained for a long period a review of the original schedule will show that many little points which affect the analysis and cost of the steel have been neglected. Although it is necessary for the melter to depart from a possible schedule of additions sometimes, if the conditions are made as uniform as possible there should not be need for it often.

Charging Considerations.

The first heat from a cold furnace often is more difficult to bring to the desired analysis than the following ones. If the interval between this and the former heat is not over three hours, charging the furnace directly after pouring the last heat would not affect the working of it. If the interval is greater, charging immediately before the power goes on is better, unless the atmosphere of the furnace can be made non-oxidising immediately and furnace sealed tightly. This is difficult to accomplish. Charging in advance causes considerable oxidation, particularly with material such as turnings, flashings and material having great surface area. The result is that by the time the power goes on there is a heavy scale on all parts of the charge. This gives a thin slag, the bath melting down low in silicon, manganese and carbon. This also is severe on the roof and lining, particularly with furnaces of heavy power-input where the violence of the arc causes considerable splashing of this thin slag against those parts of the furnace. This may be compensated by charging some of the heavier material first and adding the turnings just before starting the heat.

Once the power is on, it should not be taken off unless absolutely necessary until the charge is in a molten condition. If there is any work to be done such as changing electrodes, it should be taken care of before starting unless only a minute or two will be used. When parts of the charge are heated to a temperature ranging from 815 deg. Cent. to the melting point, excessive oxidation or scaling takes place and the slag becomes rich in iron oxide. This condition is still more aggravating where the furnace is not kept air-tight during the melt down.

All will admit the furnace should be kept well sealed. This means not only a saving in time and energy, but helps to give a uniform blanket of slag on the melt down of each heat, all other conditions being the same. This is more important on furnaces that melt slowly and where the volume of oxygen passing into the furnace is much greater because of the longer melting time. Not only is there a benefit in time, energy and control, but there is an economy in electrode consumption due to oxidation of the electrodes.

Another factor in analysis control is the silicon, carbon and manganese content of the charge going into the furnace. It would be folly to state here the requirements for all furnaces. This has to be worked out at each plant. The writer has aimed to get sufficient silicon, manganese and carbon in the charge so that when the heat is melted and fairly hot and the finishing of the heat is to start, the silicon will be about 0.07, manganese 0.09, and carbon about 0.013 per cent. If the nature of the charge has to be changed, and the silicon and carbon come higher on the charge average, a certain calculated amount of ore must be added. Melting down to the above analysis gives a suitable thin slag that is not so oxidising as to leave the bath highly saturated with oxide. It is desirable to get the residual as low as stated, because at this point the steel clings tenaciously to these elements. Therefore, if the proper mixture is used all of the heats will come close to the above analysis from which the increases can be made with regularity. If on the other hand a mixture higher in metalloid content is used, some heats on account of greater oxidation will get to this level while other heats being less oxidised will have a much higher residual content and the final analysis will show high results. In other words, the idea is to melt down to a similar condition as is obtained in converter practice and then to build up quickly to the desired analysis.

The writer has found that with the Moore-type electric furnace melting a 3½ ton heat in one hour and 20 minutes, the mixture analysis to give the above residual content is about 0.22 silicon, 0.63 manganese, and 0.30 carbon, using 50 per cent. shop scrap and about 30 per cent. turnings, the remainder being forgings and shearings. The manganese is not considered important as it depends much on the actions of its partners, silicon and carbon. If they are high the manganese will stay also.

Causes of Low Silicon.

A lower silicon than desired is due to an excessive amount of iron-oxide in melting down. An excess of iron-oxide may be due to too much oxygen over a short or long period entering into the melting chamber and attacking the steel during that time. This is aggravated if there is not sufficient silicon, manganese, and carbon in the charge to neutralise some of this oxidising power. Scrap with excessive rust and having a large surface area exposed to whatever oxygen may be about will cause an increase in oron oxide. A low silicon and carbon content of the charge will cause a more oxidised bath and slag, all other conditions being the same.

To prevent such a condition, the furnace should be kept as air-tight as possible even after all is melted. The condition of the charge should be kept as uniform as possible, both as to analysis and physical condition. If there is more rust and some of the material is lighter, the silicon content of the charge should be increased slightly. In the first heat out of a cold furnace a longer time usually is required for melting. This heat should have a higher silicon and carbon content than the others.

If after an attempt has been made to prevent it, a thin oxidising slag persists, the best thing to do is to slag off some of it so that less than the usual amount remains on the surface of the bath. Then add three or four shovels of sand, preferably silica sand, spreading it well so that it will be incorporated evenly and quickly into the slag. More may be necessary, but observation of the slag will show this, it becoming a little viscous when sufficient has been added and the steel is fairly hot. After the slag has been prepared in this manner, the bath should be rabbled to bring the steel in the lower part of the bath in contact with the slag. This helps particularly in quick melting where often the surface steel is properly deoxidised while the bottom is full of oxide. Silicon pig is then added to raise the charge to the normal silicon content on the melt-down. The increase is perhaps 8 to 10 points, allowing a little for loss.

The silica analysis of a proper finishing slag should be between 50 and 60 per cent. With a higher silica content the slag becomes a little too thick for good roof and lining life. A thin, watery, oxidising slag will vary between 15 and 30 per cent. silicon content.

* A Paper read before the American Foundrymen's Association.

Causes of High Silicon.

High silicon is usually due to either a higher melt-down than usual where the oxidation of the elements silicon, manganese and carbon was much less than normal, or to an excessive reduction of silicon in the slag with the aid of carbon.

The first condition will be noticed as temperature tests are taken; the metal will lay very quiet. Adding a shovel or two of ore as soon as possible will help. A reduction in amount of silicon to be added also is advisable. The amount to cut down, of course, depends on the melter's observation.

Reduction of silicon from silica has been a bugbear in the operation of many electric furnaces. Where the carbon content of the steel is above 0.25 per cent., considerable reduction takes place as the temperature goes up. A charge high in carbon melting down to 0.25 so that little carbon has to be added will pick up a good bit of silicon if the slag is right. With the high temperature obtained under the three electrodes, the reduction is greatest in these regions.

However, if the bath is kept at the carbon content of the proposed melt-down analysis of 0.15 per cent., practically no reduction takes place. Then if the carbon is added at, say, 2 to 3 minutes before the power is finally taken off and this time that the power is on after the carbon addition is kept the same, one heat after another, the silicons will show a surprisingly small variation, where other conditions are constant.

At the plant with which the writer is identified, the present practice in adding carbon for a regular heat of 0.25 carbon is to dip two of the electrodes into the steel just before adding the manganese. The power is on only for exactly two minutes, checked by a stop watch. The pick-up of silicon cannot vary much when this is done. The danger of high silicon from heats calculated to finish with carbon much higher than 0.25 is negligible, as the increase is obtained by dipping the electrodes at the end of the melt, after the power is off, to obtain the extra carbon.

To give a satisfactory deoxidised slag and keep the silicon, carbon and manganese stationary to the end of the heat, we have been using lately about 25 lb. of pea-size anthracite to a 3-ton heat. This is being added about 20 mins. before the heat is finished and is spread over the slag as uniformly as possible. Chestnut-size coal was tried, but it seemed that some of the heavier pieces penetrated the steel to a certain extent, raising the carbon indefinitely. Using the pea-size has eliminated this irregularity. There is a little pick-up of silicon by the bath, but this will be the same on all heats if it is introduced at the right time. This amounts to about 5 points.

A greater loss of silicon, manganese and arbon in melting down is experienced with a furnace melting slow and using graphite electrodes, than the same furnace with greater transformer capacity and using carbon electrodes. The oxygen in the chamber is readily changed to carbon dioxide by the carbon electrodes leaving a more neutral atmosphere and, therefore, allowing less oxidation. However, graphite is not so easily attacked as the loss in pounds of electrode per ton indicates. Such opposite conditions may explain the varying amounts of silicon, manganese and carbon additions used in electric furnaces of different plants.

Solving Problems of Carbon Control.

The steel seldom picks up carbon in the same sense that silicon is said to be gained. High carbon sometimes comes unexpectedly because of malfunctioning of the automatic control at the end of the heat. If an electrode breaks off and becomes partly submerged, the carbon rises rapidly. Watching the board is the best precaution possible. The hazard of high carbon is greater with the use of amorphous carbon electrodes than with graphite ones. The rate of absorption by the steel from a broken electrode is much more with carbon than with graphite.

To bring down the carbon in such cases, unless it is hopelessly high, it is advisable to keep the power on and add sand to the slag to make it more silicious. The carbon then reduces the silica of the slag and the bath therefore loses its carbon. It usually is, advisable to rabble the bath well after the electrode has been fetched out and a sample should be analysed immediately for carbon. To facilitate the lowering of the carbon the bath should be rabbled a couple of times so as to bring the high carbon in contact with the silicious slag. The above procedure may mean a little higher silicon than usual, and a hotter metal than would be desired. But it is believed that this is more satisfactory than the attending conditions when the bath is ored down, causing a greater slag burden and more unpleasant operation as well as greater wear on the furnace.

Some melters have considerable trouble in keeping their carbon up. On some heats they seem to lose more than on others. The ideal condition would be to incorporate the carbon as near as possible to the end of the heat. But when adding pig-iron, the power must be on a sufficient time to incorporate thoroughly the amount necessary, which on a 6,000-lb. heat with a residual carbon of 0.12 to 0.15 per cent., would mean 175 lb., not allowing any for loss. (Theoretically this would require about 2.9 per cent. of the time of melting the heat or about 3 minutes.) Then, again, the power would be on after the manganese had been added to the bath. Therefore, during this period there is a chance for quite a variation in loss, one heat from another. Dipping the electrodes in the bath has proved satisfactory. We have adopted the following practice after determining the rate of carbon absorption by the bath from the electrodes. This was found practicable only with graphite electrodes, the rate of absorption being much more uniform than when using amorphous carbon electrodes. When the heat has reached the desired temperature, the power is turned off and two electrodes are immersed to a depth of 7 in. for 75 sec. (total elapsed time). With our regulation it takes 15 sec. for the electrodes to get down 7 in. and allowing 15 sec. for the return they remain stationary in the bath 45 sec. This is slightly varied as indications warrant. Immediately the bath is rabbled well from both the spout and the door to mix thoroughly the metal. The power is then started, and after 15 sec. the manganese is added. At the end of 2 min. the power is taken off. The bath is again rabbled well and heat is ready to pour. Should higher carbon steel be needed, the electrodes are again immersed at the end for as long as is necessary. It is advisable to use three electrodes rather than hold any one over 100 sec. The rate of absorption changes as the carbon is removed from the electrode.

To realise the full benefits of the above method, a fracture test should be examined just before adding the carbon to the steel. This may cause a decision to vary the length of time the electrodes are in the steel.

Problems of Manganese Control.

Manganese control should be easy if the carbon and silicon are uniform. The following are pertinent points in manganese control:—(1) Lower carbon than usual means slightly lower residual manganese. (2) Lower silicon than usual results in lower residual manganese. (3) When small lumps of ferro-manganese are prevented from reaching the bath by a viscous slag, lower manganese will result. (4) Variation of the time that power is on after adding the ferro-manganese will give a corresponding variation in manganese content. (5) The volume and nature of the slag affects the control.

The first and second causes should be apparent to the melter by the time manganese is to be added, and therefore he can increase his additions slightly. The third cause is preventable, as sacks or containers can be obtained for pieces that might be trapped in the slag. Such containers serve their purpose well. The fourth factor, time, must be watched with consistent accuracy—even to seconds. Two minutes is ample time. Any longer period means the enriching of the blanket of slag with good manganese from the steel. This brings us to the fifth point. Too much slag means more manganese to satisfy the greater capacity for absorption. For this reason slagging off is desirable earlier in the heat where an extra heavy amount of slag is noticed.

The temperature of the steel has a slight bearing on the control of all three elements. Exceed-

ingly hot steel loses carbon and manganese, the manganese going into the slag and also volatilising slightly.

Closer control of manganese can be obtained when adding all of the ferro-manganese in the ladle, in small lumps, but the advisability of doing this is a matter on which there is a considerable difference of opinion.

Aspects of Control Problem.

The sample of analysis is an important factor. It should be taken from a bar that will chill quickly in the sand, say 2 × 3 × 1 in. The usual precautions for drilling samples should be kept in mind.

The test bar should be poured at the same time on each heat, preferably at the half-way mark. Tests made on samples after regular time intervals on the same heat have shown a consistent change in analysis. This was most pronounced with the element manganese, particularly when the heats were hot, the decrease being as much as 8 points from the first to the last metal on some unusually hot heats.

Mr. McLain's European Visit.

The many friends which Mr. David McLain has made in Great Britain will be pleased to learn that his physician considers that his eye has made sufficiently rapid progress to enable him to visit France. He left last Tuesday for Paris, and will be taken care of by Mr. Zeeman, European Representative of the Osborne Moulding Machine Company, and Mons. Ronceray, of Choisy le Roi. On his return he hopes to be able to visit some of the more important foundry centres.

Electric Furnace Melting Costs.

Mr. C. W. Francis, who has been writing a series of articles on the subject of electric furnaces in the *Iron Age*, gives in the issue of August 31 a most interesting comparison between the costs of making ordinary mild steel by the acid and basic electric processes. His table shows that the acid steel is 3.5 dollars per ton cheaper than basic. This is solely due to the time factor, the acid furnace being capable of being run so much more quickly than basic.

We understand that only one firm in England is making acid electric steel castings, and this works satisfactorily with a conducting hearth. There seems to be a considerable field for the acid plant in Great Britain, as considerable quantities of low sulphur and phosphorous scrap is available.

Roumania Wants Crucible Tool Steel.

The Commercial Secretary at Bucarest reports that the Roumanian Railway Administration are inviting tenders for the supply of 120 metric tons of crucible tool steel. Tenders, which should be addressed "La Direction Generale des Chemins de fer Roumains," Service P. (Calea Victoriei No. 124), Bucarest, will be received up to 11 a.m. on September 22.

Quotations are required covering delivery c.i.f. Roumanian port, and it is understood that payment will be effected in thirty to forty days after arrival of the goods in the railroad stores. The successful tenderer will be required to pay a registration tax of 1 per cent., and also to make a deposit of 10 per cent. of the value of the contract.

Representation by an agent resident in Roumania is considered to be essential, and the Department of Overseas Trade is prepared to suggest to United Kingdom firms interested in the matter the names of suitable agents to act for them.

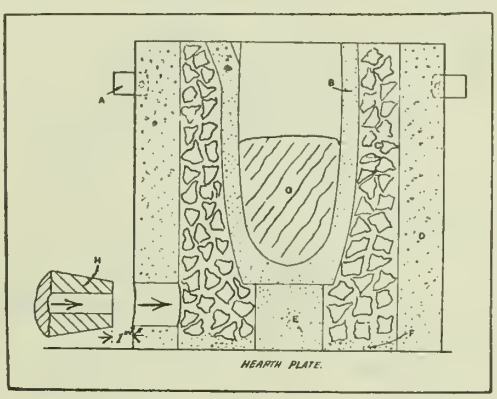
One copy only of the specification, conditions of contract, and tender form (in French) have been received and can be seen by United Kingdom firms interested, on application to the Department of Overseas Trade, Room 49, 35, Old Queen Street, S.W. 1 (Ref. 9,000/F.E./E.P.).

An Emergency Melting-Plant.

By F. A.

While on compulsory holiday in an out-of-the-way district the writer's services were requested in connection with a breakdown at a local garage. The subject was a motor-cycle, apparently scrap, unless a certain type of 3-speed gear box could be fitted. It was doubtful, even with the special fitting for securing the gear box (which would mean taking the frame to pieces and rebrazing with the fitting in position), whether the belt pulley and sprocket wheel could be got in correct alignment, and two garages had previously refused the job as hopeless. It appeared to the writer and the owner of the garage, however, that by removal of a portion of the gear-box (without affecting the vital parts) and the substitution of a special casting and clip, the trouble could be overcome and the gear-box fitted without alteration to the frame, if the castings could only be obtained. As the nearest foundry likely to be able to supply them was over 50 miles distant this looked like being a long job, even if a pattern could be quickly supplied.

Other castings being occasionally required, in aluminium and bronze, a small crucible was ordered, to hold about 36 lbs. of bronze or about 12 lbs. of aluminium, with the intention of using a small portable forge for melting purposes. By the time the crucible arrived an old oil drum, about 14 in. dia., had been cut down to about a



A=Handle. B=Crucible. C=Small coke. D=Fire-clay. E=Fire brick. F=Protecting sand. E=Metal. H=Blast nozzle.

foot, and a circular piece 10 in. dia. cut out of the base, a 2-in. hole being also cut out of the side about 2 in. from the base. A short log, about 10 in. dia., was used for a plug, while the interspace between it and the drum was rammed with fireclay. The 2-in. hole, which was intended for a tuyere or blast inlet, was carried through the fireclay and the plug removed. Whilst the fireclay was being carefully dried, a wooden, two-part moulding-box was made, and means of location provided. A crude pattern was prepared for the required casting, and whilst the aluminium was being melted in the fireclay-lined casing, set on the hearth of the portable forge, with the 2-in. hole opposite the nozzle, and coke as fuel, the mould was prepared, and within an hour was cast. Since then other emergency jobs have been cast, both in aluminium and bronze. Starting with a good fire, 10 lbs. of fluid bronze was obtained in half an hour, whilst a pot full of aluminium can be melted in 45 min.

Such a furnace would be quite suitable for emergency jobs, even in cast iron, with a little more fire space and greater depth, but naturally would be better if the blast was supplied from a small power-driven fan instead of the hand-operated lever bellows.

The illustration (Fig. 1) outlines the arrangement, which was provided with suitable handles for removal when finished with. The sand for the moulds was obtained locally.

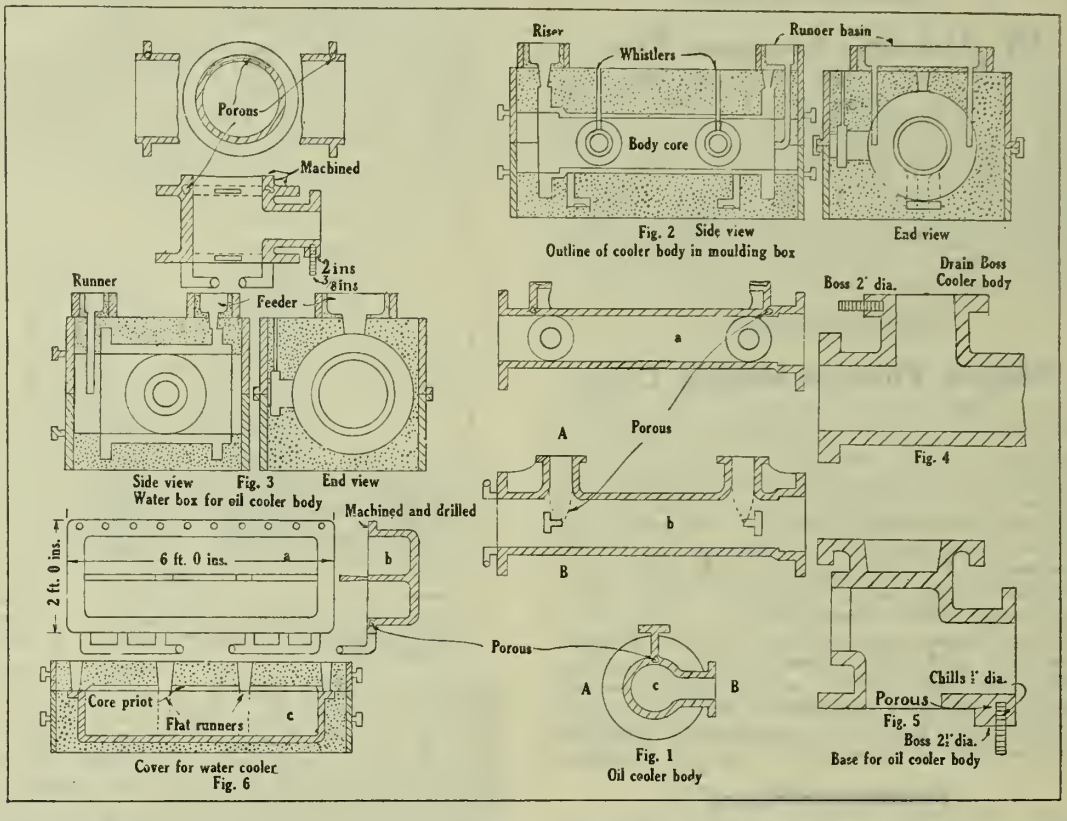
The Star Foundry Company, Limited, of Batman's Hill Road, Cosely, Bilston, have just constructed a new foundry for non-ferrous castings.

Pressure Trouble with Oil Cooler Castings.

By S. G. Smith.

The castings discussed in this article are for oil cooling and consist of bases, bodies and water boxes, being bolted together to form an important part of the oil cooling arrangement.

The castings are all pressure-tested separately, and must be perfectly sound before being assembled. The cooler bodies vary in dimensions both in diameter and length according to the quantity of heated oil to be cooled. The diameter of bore would be approximately from 6 to 12 in., and the length from 4 to 6 ft. The dimensions of the bases and water boxes would correspond to the cooler bodies. Regardless of size, the defects were very similar. Fig. 1 shows a cooler body, which, as a rule, are bored out to a definite size, in order that the perforated discs should have a true inner surface. These round discs, several of which are used in each cooler body, hold together the numerous brass pipes, through which the cold water passes to cool the oil. Thus the discs and the brass pipes must be true fitting.



Porous Plates.

In Fig. 1 three through sectional views, *a*, *b* and *c*, are given in order that the position of the porous places may be clearly understood. These are indicated by arrows.

When the writer took this trouble in hand the castings were poured as shown in view *a*, *id est.*, the brackets were uppermost, which was the basic cause of the porous places. At the dotted lines in view *b*, Fig. 1, where trouble was also experienced, spread on the branch cores, which were carried a quarter way round the circumference of the body, was, by consent of the engineer, reduced to a plain diameter spread, as shown in views *b* and *c* (Fig. 1).

The brackets near to arrows were altered to mould the opposite way, as shown in Fig. 2, which includes a side and end view of the outline of the casting in the moulding box as poured.

Reversing the method of pouring, reducing the spread on the branch cores, and running the casting from the opposite end to the gland end, each contributed to eliminate the porous and faulty places. In addition, these castings must always have the best conditions, such as a clean mould, good cores, and good hot iron.

If at any time it is considered with the larger-sized cooler-bodies to pour vertically, all precautions consistent with vertical moulding and pouring must be taken, otherwise more trouble will follow than when poured on the horizontal.

Water Box.

Fig. 3 shows a water box, and is attached to the gland end of the cooler body. The chief faults associated with the castings are porosity in the two places indicated by the arrows, and have reference to the spigot-end (where shown machined) and the boss for the drain cock which adjoins the branch flange. The castings were moulded and poured as shown in the side and end view of the moulding boxes, and were rammed on a jolting machine.

To overcome porosity at the spigot end, an enlarged feeder was fixed on the pattern as shown in the centre sketch of Fig. 3, the side and end view of the moulding showing this more clearly. Care had to be taken that the swell on the side of the flange which remained on did not interfere or foul the drilled bolt holes. Of course, this enlarged feeder required to be rod-fed as long as possible, otherwise the porosity would almost have been as great as before. The porosity continued for a third of the diameter as shown. Many castings did not reach the water test, but were scrapped during machining, the porosity showing up during operation. The drawn place which existed in the boss for the drain cock shown in the centre sketch was overcome by a very simple remedy, which will be referred to in the next two Figs. 4 and 5. Both methods adopted were quite satisfactory.

Cooler Body.

Fig. 4 is an end section of a cooler body, and Fig. 5 is a cross section of the base, which is bolted to the end of the cooler body. Each of these castings has a drain-hole boss. As only a ½-in. or ⅜-in. dia. gas tap passes through the boss, it is cast solid, drilled and threaded according to requirements. Almost without exception every casting, whether it be cooler body, water box, or base, has shown porosity at this boss.

The chills do not pass right through to the core, this being arranged so that the mean thickness of the section can be allowed between the end of the chill and the body core. The diameter of the drain bosses and the diameter of the chills are different, in order to accommodate in the latter

the size of the boss, the size of the tapped drain hole being previously ascertained. For instance, a 2½-in. dia. boss would have a ⅜-in. gas tap, the diameter of the chill was decided upon as ½-in. The 2-in. dia. boss would have a ½-in. gas tap, and the diameter of the chill would be ⅝-in. These small chills, or denseners, were most effective. The boss, when drilled and threaded, was perfectly sound and water-tight. The chill is self-centreing in the mould, a print being added to the pattern. The length of the print decides that the longest half of the chill will be in the print; this also determines the length of chill that extends into the casting. When the mould is closed, the print will hold the chill firmly in position. This is essential, as there is only a small margin allowed around the chill, as is shown in Figs. 4 and 5.

Cover for Cooler Body.

Fig. 6 shows a cover for a water-cooler. The trouble with these castings is usually due to the position of the runner-ingates indicated by dotted arrows on sketches *a* and *b*. The spray runners were cut along one side of the cover as shown; consequently, when the castings were machined and drilled on the runner side of the cover, the flange was full of porous places indicated by arrow on sketch *b*. This was so bad that a wire could be passed from one drilled hole to the next. Hence some castings were rejected before reaching the water pressure test, whilst others were rejected due to failure at the test. The opposite and end flanges were perfectly sound. The drawn places were found in the hottest parts, which remain therefore longest in the liquid, or semi-liquid condition occasioned by the last or hottest metal from the ladle remaining opposite the ingates in the drawn flange. This occurrence is by no means uncommon.

The remedy for such drawn places is a better and a wider distribution of the molten metal through the runners, and in this case the position of the runner gates was moved from the flange to the centre dividing rib, as shown, passing through sketches *a*, *b* and *c*. Sketch *c* also shows the cover on the moulding box.

If no rib existed in the design of this casting the best method of gateing would be through the centre of the core, as shown at continued dotted lines of the flat runner.

Austrian Iron and Steel Industry.

Present Conditions.

According to a recent article in "Commercial Reports," there are now in operation in Austria 3 coke blast furnaces of a capacity of 400 tons of pig-iron per day each, and 2 small charcoal furnaces of 13 tons per day each. This is about 50 per cent. of the total capacity of the 11 blast furnaces in the country. The production of pig-iron for the first quarter of 1922 was about 22,000 tons per month; the actual amount increased from about 20,000 tons in January to 24,000 tons in March.

Of the 74 steel furnaces in the country, 30 furnaces (17 open-hearth, 4 crucible, and 9 electric) are in operation, giving an average monthly output for the last quarter of 1921 of 28,600 tons, of which only 1 per cent. was crucible ingot steel. The total steel production capacity of Austria is about 60,000 tons per month. There are some 25 iron and steel rolling mills, producing at present (April, 1922) about 40 per cent. of their capacity. This production is increasing, but is dependent upon the supply of raw material obtained locally and by importation from Germany and Czecho-Slovakia. Practically all rolled products are made, especially bars, sheets and plates, rails and other railway material, structural work and wire.

The production of pig-iron is almost wholly by the Alpine Montangesellschaft which has all of the blast furnaces operated with coke and one of those operated with charcoal, besides large steel works and rolling mills. It has an abundant supply of high-grade iron ore but must import all of its coke and most of its charcoal. Until a year ago it was entirely dependent upon Czecho-Slovakia for coke, which was limited in quantity and burdened with the condition that half of the pig-iron produced should be exported to Czecho-Slovakia. When the Stinnes group acquired control of the Company, coke was secured from the Ruhr district in Germany, and the production was much increased.

The Ruhr coke at the end of March cost about 65,000 Austrian crowns per ton, but the supply was uncertain, the Allies making difficulties and requiring the purchase of English coal, paid for in English money, in substitution. Czecho-Slovak coke was at the same time plentiful, but cost 110,000 crowns per ton delivered at the furnace.

The Alpine Montan Company is planning to increase its capital and to enlarge its capacity for pig-iron production by 40 per cent., and for steel production by 20 per cent. The details have not been given out officially, but it is reported that the Company is indebted to the Vienna banks to an amount exceeding 8,000,000,000 crowns and that in order to reduce this indebtedness and enlarge its works and build workmen's houses it intends to raise its capital from 100,000,000 crowns to a nominal 600,000,000 crowns, issuing the new shares at a price equal to one hundred and fifty times their nominal value. (The exchange rate at the end of August was 300,000 to 350,000 Austrian crowns to the £.)

In the second half of 1921 the Austrian imports of iron and steel were 30,962 tons, the chief items being foundry pig-iron (24,653 tons) and scrap (3,720 tons). Of this 58 per cent. came from Germany and 39 per cent. from Czecho-Slovakia. There were imported 7,052 tons of semi-finished iron and steel, of which 70 per cent. came from Germany and 3.2 per cent. from Czecho-Slovakia, the chief item being 4,769 tons of puddled bars. Germany supplied 65 per cent. and Czecho-Slovakia 33 per cent. of the 56,647 tons of finished iron and steel imported. Prominent among these imports were 18,873 tons of bars, 11,459 tons of sheets and plates, and 2,924 tons of wire.

Germany and Czecho-Slovakia have a monopoly of the Austrian market at present.

Austrian exports of unfinished iron and steel in the second half of 1921 amounted to 31,175 tons, the chief items being pig-iron, 11,572 tons, and scrap, 2,400 tons. Germany took 6 per cent. of these exports, Czecho-Slovakia 66 per cent., Hungary 3 per cent., Yugo-Slavia 5.8 per cent., and Italy 12 per cent. In the same period 4,478 tons of semi-finished iron and steel were exported, 52 per cent. of which went to Yugo-Slavia, 17 per cent. to Germany, 3.6 per cent. to Poland, 1 per cent. to Hungary, and 0.5 per cent. to Czecho-Slovakia. Finished iron and steel was sent abroad to the amount of 71,408 tons, the most important items being bars 18,131 tons, plates 8,938 tons, wire 7,791 tons, and hardware 36,551 tons. Yugo-Slavia bought 37 per cent. of these products, Germany 14.3 per cent., Poland 11 per cent., Czecho-Slovakia 7.8 per cent., and Italy 7.6 per cent.

MR. S. BOOTHROYD, of 23, Edmund Street, Bradford, has been appointed agent in the North of England for the Burton Foundry Company, Anglesey Road, Burton-on-Trent.

MR. J. LONGDEN, who has been acting as assistant secretary to the London Branch of the Institution of British Foundrymen, has been appointed foundry superintendent to D. & J. Tullis, Limited, Kilbowie Ironworks, Clydebank, Glasgow.

Tata Iron and Steel Company.—A cable from Bombay states that the report of the Tata Iron and Steel Company for the year ending March 31, 1922, shows a profit of 88¼ lakhs (£588,333). No dividend is to be paid on the ordinary shares. The report refers to the past year as one of the worst the iron and steel trade ever experienced, with prices constantly falling and the cost of production increasing, but considers that the Company's results may be regarded as successful when compared with those of similar concerns in other countries.

Malleable Iron or Semi-Steel Scrap?—Mr. Commissioner Finlay had to decide this question at the Warwickshire Summer Assizes. An action was brought by Messrs. Cox & Danks, iron and steel merchants, of 168, Regent Street, London, to recover £421 for scrap supplied to the Reliance Foundry Company, Willenhall. The defendants alleged that some scrap material sold was steel or semi-steel and not malleable iron scrap, but Mr. Commissioner Finlay decided that there was no misdescription, and gave a verdict for the plaintiffs.

Position in the Australian Iron and Steel Industry.

The Australian mail recently to hand contains a report of an explanatory statement issued by the Broken Hill Proprietary Company, Limited, in regard to the present position of the iron and steel industry in Australia, with special reference to the Newcastle (N.S.W.) Works.

At the outset they mention that twelve months ago between 5,500 and 6,000 men and officers were employed at the steelworks at Newcastle. At the time of the report (June 22, 1922) only 840 had employment. After careful examination of the situation as it appears to-day, the directors have come to the conclusion that there are three main things necessary to be overcome to enable the Company to quote sufficiently low prices to meet overseas competition and thus enable them to receive orders and restart the steelworks. The three main factors are:—(1) Price of coal; (2) the matter of hours; (3) wages.

Coal.—The directors think that they will be justified in restarting the works if best or large coal is reduced by 4s. per ton, and small coal by 6s. per ton. Since the iron and steel industry has been started at Newcastle, the price of large coal has been increased from 11s. to 21s. 9d., approximately 100 per cent., but small coal has been increased from about 7s. to 17s. 9d. per ton, equal to 153 per cent. increase. As three tons of coal are required, approximately, to produce a ton of steel, the enormous increase in the cost of manufacturing steel is shown.

Hours.—In the matter of hours, the Company have been placed under a great disability by the institution of the 44-hours' week, and it is necessary for 48 hours to be reverted to before operations can be commenced.

Wages.—The latest basic wage in New South Wales is £3 18s. per week, and the Company are unable to start under this finding; they could, however, start at a minimum wage of £3 10s. per week. In the iron and steel industry in England ordinary unskilled labour received a weekly wage of 47s., and in the United States 60s. per week.

In addition to these conditions, several adjustments of a minor nature with the New South Wales Government are essential.

The Company are hoping to further assist the position by salary reductions, better general efficiency, improved methods, and lower freights. The Company's policy is to have some of their technical officers always travelling abroad in order to keep the works in line with the most modern practice.

The cost of coke at the Newcastle steelworks manufactured in up-to-date ovens in 1921 was 37s. 4d. per ton. English coals are very much lower in ash than those used for making coke in Australia. In addition, English coal mines produce coal of various grades, and it is the fines or "duff" of these coals which is used for making coke in England and America; whereas in Australia there are only two classes of coal produced—viz., best and small. In Newcastle it is the small coal which is used for making coke, but unfortunately there are insufficient quantities of smalls in Australia with coal mines on low output. It is therefore necessary to use a certain amount of large coal also. The f.o.b. price of small coal in Newcastle in June was 17s. 9d. per ton, but owing to the insufficient quantity of small coal the cost of coal for coke-making purposes was 19s. 3d. per ton.

Statements have appeared in the Press misleading the public regarding the amount of capital invested by shareholders in the steelworks at Newcastle. It is thought that the fairest way to explain this position is to quote from the report of an independent accountant, appointed by Judge Beeby, to inquire into the Company's books as to costs and capital invested. Mr. Watt (the accountant mentioned), in his report dated March 16, 1922, clearly shows that, at November 30, 1915, the various funds belonging to the shareholders were as follows:—

	£	s.	d.
Subscribed capital	472,402	8	0
Premiums paid by shareholders in 1918 on issue of shares ...	353,609	12	0
Up to May 31, 1921, there was a further issue of shares which increased the capital by ...	480,534	12	0
And, in addition, premiums paid by shareholders on these shares	954,206	13	0
Making a grand total of money subscribed in cash by the shareholders of	2,260,753	5	0

Further, £2,500,000 was raised by debentures subscribed by the public, and was also expended in establishing the Newcastle industry. Thus the total amount of money subscribed by share and debenture holders for the establishment of the steel industry at Newcastle amounts to £4,760,753 5s.

In addition to the above, from the sale of the lead smelters at Port Pirie, and from undivided profits derived from Broken Hill, a total of £1,800,000 was expended in establishing the industry at Newcastle, which amount was subsequently capitalised. Of this £1,800,000 an amount of £1,500,000 was issued from undistributed profits which had been allowed to accumulate whilst the Company's business was being developed.

Of the above amount, £1,178,000 had been accumulated prior to May 31, 1914, which was before the steelworks had commenced operations.

The following quotation is taken from Mr. Watt's report to Judge Beeby, viz.:—"I have to report that since 31st May, 1914 (the first period investigated by me), the undistributed profits belonging to shareholders had been represented in the balance-sheet by way of income-earning assets, and they have thus increased the shareholders' general funds invested in the business. I desire also to state that the issue of £1,500,000 worth of bonus shares has been made without writing up the value of any of the Company's assets, and without reconstructing in such a way as would create any such intangible assets as good will. The net effect of the recapitalisation scheme adopted in 1918 and 1919 was merely to have certain shareholders' funds (accumulated profits), which were invested in an extension of the Company's business, recognised as shareholders capital."

U.S. Steel Workers' Wages.—The Bethlehem Steel Corporation, the Midvale Steel and Tube Company, the Brierhill Steel Company, and the Republic Iron and Steel Company, following the lead of the United States Steel Corporation, announce their intention of making a similar increase in the wages of day labourers. Pig-iron was sold at Birmingham, Alabama, on August 23 for $25 a ton, being the highest price since the war.

Zinc Absorption by Blast-Furnace Linings.—Mr. P. O. Menke, in a paper before the Eastern States Blast-Furnace Association (U.S.A.), points out that zinc vapour in iron ore is absorbed by the lining up to as much as 50 per cent. It usually shows up as small yellow crystals. Sometimes it is found with carbon deposits in the disintegrated and laminated portions of the lining. Some of this zinc shows up in the metallic form. It usually is around the water-cooled part of the furnace, also in the part of the lining that is not water-cooled, but had a chance to cool down after banking or blow out. In scabs that adhere to the water-cooled portion of the furnace, it probably combines with the alumina, forming zinc spinel, which is practically irreducible, as these scabs are mostly still present and intact after the furnace has been blown ont. It is also generally assumed that the zinc oxide combines with the alumina in the fire brick. As the coefficient of linear expansion of zinc is like 60 to 1, compared to silica (which is the principal constituent in fire brick) and is about 3 to 1 compared to steel, it can readily be seen that it would not take a great deal of impregnation to destroy the bond of the brick and exert great expansive stresses. The hand-made brick, on account of its greater porosity, has a tendency to take up more of this element than the steam-pressed brick. Most of the blue billy agglomerates carry zinc. No matter how low the percentage of zinc is in the raw material, on account of its being accumulative, it will eventually show up and disintegrate the lining.

American *versus* British Cast Iron

Mr. G. K. Elliott has used "The Canadian Foundryman" as a means of expressing his views. Mr. Elliott is well-known to British foundrymen, having been the first American author of the Exchange Papers. His communication reads as follows:—

It is with the closest interest that I have read this spirited and wholly praiseworthy exchange Paper. As an international Paper it is admirable, because of the insight it gives Americans into important points of British grey-iron metallurgy, and because of its very attractive controversial possibilities. The Paper cannot help but redound to the great good of grey iron theory and practice in both Great Britain and the United States.

There are two kinds of iron castings—those made from appropriate iron especially formulated for the particular castings, and those made from common nondescript cast iron which, while broadly useful, is not generally a felicitous choice for particular requirements. We suspect that Mr. Cook is comparing, in parts of his Paper, British iron of the first class with American iron of the second. If our British friends have found some American machine-tool castings faulty, it is possible that they belonged to the last class; especially would this be true if these castings were made under stress of war conditions when some manufacturers found their own foundries too small, and were forced to let out a part of their castings with a lack of discrimination that often was unavoidable. In this country, as in England, it is possible that machinery builders who make their own castings have the iron under intelligent control producing castings equal in every way to the demands of the intended service. I am a persistent advocate of specialisation in foundry irons, and therefore hail this part of Mr. Cook's Paper with special satisfaction, because it adds emphasis to a point all too little realised in some engineering circles. There is far too much needless obloquy attached to cast iron simply because a few manufacturers, through either ignorance or carelessness, are habitually allowing questionable grades of iron to enter into important castings.

Growth of Cast Iron.

Mr. Cook mentions reported failures of cast-iron parts in America under exposure to superheated steam. This phenomenon of growth and warping under superheated steam has been referred to by American writers with more frequency and emphasis than are justified by the instances of its occurrence. A search of technical literature shows that the most of the references go back either directly or indirectly to three Papers read before the American Society of Mechanical Engineers over twelve years ago. The number of cases reported since then is very small. These mentioned are not to be denied, but my long experience in this line convinces me that when fittings intended to handle superheated steam are made from appropriate iron the danger of failure is remote, except possibly where most uncommonly high degrees of superheat are used. I have yet to see the first valve or fitting made of suitable iron that has failed under this service. It is certain that cast-iron parts made by American manufacturers specialising in this line and making their own castings are made of iron entirely capable of encountering successfully the feared but somewhat over-estimated superheat peril.

Mechanical Strength.

The average of over 36,000 lbs. per sq. in. tensile strength attained by Mr. Cook bespeaks the sterling foundryman, and suggests that his iron falls within the category of special irons; at least, it would be unfair to set it up against iron of the common variety. Quite interesting in this same connection would be a record of strengths of iron melted in the average English jobbing foundry. I myself have seen many hundreds of heats of iron run without the aid of steel additions, having an average tensile strength corresponding almost identically with that obtained by Mr. Cook; the iron, however, was formulated for a particular purpose, and should not be compared seriously with the product of the ordinary foundry catering to a not fastidious trade. Mr. Cook's tensile and "arbitration" strengths in Table I. are highly commendable, but should not reflect unfavourably upon American iron, because his bars were cast on the main castings, while the arbitration bars were cast separately. It is well known among foundrymen that test-bars can be located so favourably in relation to the main casting, when "cast on," as to give great advantage to the bars even to the extent of giving a grossly exaggerated indication of the true strength of the iron in the main casting.

The attempt to reconcile the strength of the 1¼-in. round American arbitration bar with that of British 1-in. square bars by use of the factor 0.74 is not to be commended, because no account seems to be taken of the quite different manner in which square and round section bars form crystals while cooling. Mr. Cook used this same device in his very able and keen discussion of my exchange Paper before the Institution of British Foundrymen last year, and it is again referred to, where he calls attention to the fact that his lowest "equivalent load"* (evidently obtained through the 0.74 factor) was higher than the transverse strength of electric furnace refined iron mentioned in my Paper. Mr. Cook seems to take it for granted that the strengths mentioned in my Paper were exceptional for American iron. This was far from being the case; they were not given as being the last word in cast-iron test-bar strengths, but rather as illustrations of the improvement wrought in irons of somewhat lowly origin by treatment in the basic-hearth electric furnace. The strengths were shown in pairs, so as to depict the same iron before and after treatment, and so doing fulfilled their only mission of showing that the process materially improved the original cupola metal. That the strengths were in any way exceptional was not claimed. Purposely did I avoid injecting the phenomenal into the Paper, which fact does not seem to have been understood by several British commentators.

In the case of carbon in cast iron, I am sure it will be found that more iron foundries in this country pay attention to it than Mr. Cook suspects. These naturally do not include the great rank and file of unspecialised foundries already mentioned, but only such as make the better grades of castings. In making fittings for superheated steam, for instance, certain foundries pay great attention to the amount, the size, and the distribution of the free carbon.

Sulphur Question.

The sulphur question is taken up in the Paper, and it is safe to assume that this is one question that never will be settled to the satisfaction of everybody, especially of persons who, through geography or economy, are somewhat inescapably tied fast to high sulphur. To a less extent this also is true of phosphorus, in considering which Mr. Cook makes the important observation that its distribution is of utmost importance, that segregated phosphide is more dangerous than the uniformly distributed. It is my belief that high phosphorus and high sulphur will become less dangerous only when foundrymen learn a way to produce without fail both phosphides and sulphides in a certain optimum degree of dispersion and of certain critical particle size. I do not believe that foundrymen have yet learned the way to do this, but discussions such as Mr. Cook's will aid greatly in throwing the desired light upon the subject. As matters now stand it seems that sulphur and phosphorus are safest when absent.

Dynamic Tests.

I am much pleased to see Mr. Cook refer to tests of a more dynamic nature than the usual tensile and transverse tests. It is to be hoped that a more general adoption of dynamic or shock tests is near at hand, for I believe these tests will greatly increase our knowledge of the differ-

* See Issue of July 20, page 60, col. 1.

ences between irons now apparently the same, as far as the usual static tests go, and yet which do not show up the same in service. I have in mind two sets of valve body castings weighing about 600 lbs. each that were broken up under a foundry drop-weight. One set was made from iron having about 0.08 per cent. sulphur and an average of two drops of the weight was necessary to break each casting. The other set was made of the same iron, but refined in the electric furnace, with sulphur at about 0.035 per cent.; these castings required four or five drops each to be broken. By transverse test the second iron was about 35 per cent. stronger than the first, by the drop test it was over 100 per cent. stronger.

Hot and Cold Blast.

The theory advanced in the Paper and attributed to Mr. J. E. Fletcher, concerning the relative effects of hot and cold blast furnaces upon the structure and properties of grey iron, is, by way of contrast, strongly suggestive of the thought advanced by the late J. E. Johnson in his theory of oxygenated iron. Johnson's theory is that the cool running charcoal blast furnace causes a certain marked oxygenation of the iron, which condition in turn, he contended, effects a compactness of the graphite formation that is not to be found in the product of the hotter running coke blast furnaces. On the other hand, Mr. Cook bases his claims for superiority in the iron from the cool running furnace, upon a quite different assumption—that through lack of oxidising conditions a certain boundary-inter-cohesional strength is preserved in the metal. Therefore, we are confronted with two theories, both touching upon the question of oxygen, and both claiming excellent properties in iron made in cool blast furnaces. One, however, attributes the superiority to oxygen picked up under the named conditions, while the other declares the iron to be superior because the same given conditions are not favourable to the taking up and retention of oxygen. Both theories touch upon fundamentals of the greatest interest, but neither is convincing, and we feel justified in demanding more and better evidence.

Molybdenum Steel Rolls.

In a recent issue of the *Blast Furnace and Steel Plant*, reference is made to the use of molybdenum steel rolls in rolling mills. These rolls are now being employed for the strongest roughing roll to the hardest finished roll. They are stated to be exceptionally tough, and will withstand long wear and tear.

Molybdenum rolls are estimated to give 200 per cent. increased service over carbon-steel rolls. It is believed that the use of these rolls will allow of a great increase in size of the entering billet, perhaps by as much as 30 per cent.

It is claimed that the introduction of molybdenum steel for rolls represents the greatest advance in the rolling mill practice that has taken place during the last 25 years.

Sulphur in Cast Iron.

Mr. G. K. Elliott, in a Paper read before the American Electrochemical Society, entitled "The Cast Iron as Produced in the Electric Furnace and Some of its Properties," states that it seems that the sulphur question is involved in the greater one of general refinement, and it is probable that iron high in sulphur also is endowed plenteously with other impurities, some of which may be almost entirely unknown. Examples are oxygen in various combinations, nitrogen as nitride, and perhaps others even less familiar. The fact that an iron is desulphurised is evidence that it has passed through a strong refining treatment, and the possibility that some of the benefits attributed to low sulphur in reality may be the result of the removal of one or more other impurities along with it, has to be recognised. Desulphurisation of iron means one of the most drastic cleansings known to metallurgy and consequently low sulphur is becoming a hall-mark of refinement.

Foundry Trade Technical Society.

New Organisation in Sheffield.

A progressive step was taken on Sept. 7 by the representatives of the foundry industry of Sheffield and district. At a meeting in the Applied Science Department of the Sheffield University it was decided to form a trade technical society similar to those established in the interests of the cutlery trade, the silver trade, the file trade, the edge-tool trade, the rolling mill and forge workers.

The need of such a society for the foundry trade, including iron, steel and brass trades, was clearly put by Professor W. Ripper, who presided over the inaugural gathering. He said the trade technical societies had been of considerable help to the trades with which they were associated, for they provided a means by which persons engaged in the respective industries could meet on neutral ground and discuss frankly their difficulties with the object of finding ways to overcome them. All the leading industries of the country, said Dr. Ripper, were assisted by scientific societies which were concentrating on their various problems and doing valuable research and pioneer work. But this was not all that was required. They must also be provided with opportunities to enable the workers to take some share in promoting these developments, and to enable that great body of men, who were neither students of technical schools, nor members of scientific societies, to take a useful share in considering existing methods and the ways and means of improving them. He was satisfied that the Technical Trade Societies provided such facilities. There were great possibilities in this movement, and the workmen had already shown unexpected interest and had taken a lively part in discussing the lectures and papers which had been put before them.

Representatives of the various sections of the foundry trades expressed their readiness to further in every possible way the objects of the new trade society, and the following resolution was unanimously passed :—

"That this meeting of representatives of all sections of the foundry industry of Sheffield and district approves of the proposal to establish a trade technical society for the Sheffield foundry trades."

Speaking in support of the resolution, Dr. Longmuir, a Past President of the Institution of British Foundrymen, warmly welcomed the proposal, saying there was room for such a society, and especially as a means to convey to the workers in their own language, and without the use of difficult scientific terms, information on questions which were being discussed in scientific lectures and journals. From his own experience he could tell them of the excellent results that had already been effected by helping the workers to a knowledge of the why and the how of the various results which were achieved in everyday practice. He believed the movement would receive the support of all the branches of the foundry trade, as it would bring together employers and employees on a common platform to discuss their problems from their own particular point of view.

A programme of lectures and papers has been prepared for the forthcoming session. The gathering considered and approved of a list of officers for the society. These will be submitted to the first general meeting, which is to be held on October 18.

American Blast-Furnace Practice.—The rule for rating the capacities of blast furnaces adopted by the Southern Ohio Pig-Iron & Coke Association is based on the burning of a certain amount of a "base" coke in a given time (60 lbs. coke per cub. ft. of working volume in 24 hours). Starting with the idea that there is a definite rate of combustibility for a standard coke, assuming that the ore mixture contains 51.50 per cent. iron in the natural state, and arbitrarily using 1,800 lbs. of coke per ton of basic pig-iron when the fixed carbon in the coke is 90 per cent., it is a simple process to determine what any blast furnace should make under varying conditions of coke, ore mixture, and percentage of silicon in the pig-iron.

The Imperial Tube Works of Stewarts & Lloyd's, Limited, Airdrie, are restarting on full time after a lengthened period of slackness.

Production of Steel Castings.*

By F. Darley.

(*Continued from page* 202.)

For the moulding of a fly-wheel, 14 ft. 4 in. dia., cast in three pieces, the arms and rim were made as two separate castings, split between each arm at the centre, thereby relieving any casting strains which may be set up in cooling. The boss is also made as a separate casting, arranged to be built in between the arms, and when bolted together these three pieces form a well-built wheel, free from any internal stresses, and safe to run at a speed of, say, 10,000 ft. per min. on the periphery. The total weight of this fly-wheel was 25 tons. This wheel was moulded in the floor and struck up by means of board and spindle. The arms were formed by cores and covered with a flat top plate.

Nozzle diaphragms as used for the Brown-Curtis design of turbine are cast in halves, machined and fitted together. The blades are made from rolled steel plate, either low-carbon mild steel or nickel steel. They are placed in the mould and cast in. Messrs. Firth's are at present experimenting with stainless steel blades, and the writer has every confidence that they will be a success, and will show a great advantage on account of a much longer life through being non-corrosive, and at the same time reducing the difficulty which exists with ordinary blades owing to their liability to fuse during casting. Additionally, the contraction takes place very irregularly, causing slight variation in the width of the nozzles, and sometimes buckling the blades slightly. In spite of these many difficulties, the writer has made a fair number of these castings successfully.

Stainless Steel Castings.

A new branch in the steel-casting industry, to which the writer is looking forward and hoping to make a success, is the manufacture of stainless steel castings. Already the writer's firm has made some rather intricate castings up to 10 cwts. successfully. Probably the greatest demand will be for castings from a few pounds upwards, such as internal parts for valves, acid or chemical pumps, or any purpose where corrosion or high temperatures are a serious matter. In the near future it may be used extensively for screw propellers.

This steel, in the form of castings, has a tensile of about 50 tons per sq. in., with about 12 per cent. elongation, and 90 per cent. bend. The difficulty and the peculiarity of stainless steel is that it is not stainless until it is specially heat-treated and the outer surface freed from all oxidising matter. This can be done, and the successful commercial production of stainless castings will, in the near future, be an accomplished fact. This steel, as is generally known, was first discovered in the Brown-Firth Research Laboratory, and is made extensively in the Firth works.

Large hydraulic shear standards, two of which form a pair of large bloom shears capable of cutting hot blooms 15 in. by 30 in., and are 17 ft. high and weigh 25 tons each, are moulded from a complete pattern in the floor. After the pattern is drawn the mould is finished and dried, and the cores which form the internal parts there are over 40 in number. This is a very difficult casting to make on account of the varying thicknesses and cross ribs which make it liable to pull to pieces in cooling.

Engine Wheel Centres.

In the early days of casting engine wheel-centres there were many failures. The castings were allowed to cool in the moulds, but when they were taken out and examined they were very often found to be either broken or pulled to pieces. Later the moulds were released, the wheels taken out soon after they were cast; but in spite of every precaution about 75 per cent. were either piped or pulled, and when they did come out of the mould whole they rarely went through the annealing and drop test successfully. The difficulty was eventually overcome by altering the quality and composition of the steel and by regulating the refractory material to suit the different thicknesses, while to-day it is pleasing to note that it is seldom that a waster wheel-centre is made. Two wheels were recently taken at random by the inspector and broken up for destruction test. They stood flattening and buckling up again before they could be broken, and when they were finally broken by means of a tup, all the fractures were perfectly solid, which alone proves the great improvements that have been made during the last few years in this class of casting. The reason why steel castings are so much more difficult to deal with than iron castings is that iron is much more fluid and easier to run, and the contraction of cast iron is only one-tenth of an inch per foot, while steel suitable for magnets 5/32, ordinary carbon steel 7/32, and manganese steel 9/32 per foot contraction is the cause of pulling, piping and clinking. A pull takes place when the casting is cooling from the fluid to the solid, say, at a plastic stage, and nearly always in the thickest parts which are generally opposite to a rib or bracket on account of this part either not being properly fed or being the last part to freeze, is too weak to resist the contraction which begins to take place immediately after the job is cast. The writer's opinion is that a casting will not pull after it has cooled below 800 deg. C.

Piping.

This also is the result of contraction. Taking an ordinary ingot cast either in a sand or iron mould, no matter whether it is fed from the bottom or top, it will pipe anything from 15 to 30 per cent. of its length, unless some artificial means are adopted to keep it hot at the top, until the main part has solidified. This is done sometimes by means of a fireclay nozzle placed in the top of the mould. If the top of an open ingot mould is examined a few minutes after it is cast it will be seen that it begins to contract or sink at once. What happens is that the steel, which comes in contact with the sides of the mould, freezes first and fixes into shape, while the centre part is still fluid or pasty, and will continue to feed down by gravity as long as there is any fluidity left. The metal always clings to the outer walls of the ingot, leaving a cavity from the top, down the centre of the ingot. Therefore, seeing the difficulty experienced in making a solid ingot, one can imagine that it is much more difficult to make a solid steel casting of large area and of irregular thickness.

Clinking.

Clinking or flying, this also is caused by uneven contraction and irregular cooling. Castings that are liable to clink are large spur wheels in back, or fly wheels, over 7 ft. dia., with rim arms and boss cast in one piece, unless they are split in the boss to allow freedom in contraction. A press crosshead, broke across on account of the outside cooling and contracting first and setting up a compression on the internal ribs and boss, which would keep hot some time after the outside has cooled and consequently finished contracting, and when the inside eventually cools a tension is set up on the centre arms and ribs, which is resisted by the outside. So much so that a smart blow with a hammer, or a bump, will often cause one or more of the arms or ribs to break.

Blow Holes.

Another difficulty which has not yet been entirely overcome are blow or gas holes in castings. There are several causes for this. One is insufficient venting of the mould to allow the accumulated gases to escape, which means that the gases are trapped in the mould so that the fluid steel will flow over it and trap it, and so cause blow holes

* A Paper read before the Newcastle and Sheffield Branches of the Institution of British Foundrymen.

wherever there is a particle of gas or air covered by the molten steel. Another cause is through the mould not being thoroughly dried, which causes steam to generate so soon as the hot metal comes in contact with the damp mould, which will sometimes blow out a quantity of the molten metal. A third cause of blow holes is through the steel not being properly "killed" or finished in the melting, which makes the metal "wild" when it comes in contact with the mould, so much so that it will not lie in the mould, and rises in the head similar to a cauliflower. It is then one mass of blow holes under the skin, and should be all scrap. Another frequent cause is on account of the steel not being fluid or hot enough to drive out the gases which accumulate in the mould. Therefore, given a perfectly constructed mould, and steel of the correct quality and temperature, there should not be much difficulty in this direction. Keeping large castings to their correct shape during casting and annealing requires some careful consideration. Take, for instance, a ship's stern frame or shaft brackets and the like, which are anything from 10 to 30 ft., and in some cases longer. These castings very rarely come out of the mould to the required shape, owing to contraction resistance, which is of a definite quantity. The correct way is to so construct the patterns as to anticipate the expected deformity, but sometimes the castings are deformed in the opposite sense. Plant must then be provided to correct them, after they are fettled, either by local heating and bending by means of weights or jacks, or during annealing, which is really the more scientific way. First, the job is measured, and where and how much it is out of shape noted and marked. The casting is placed in the furnace and packed up very carefully, allowing for any high places in the packing, and put weights on so that when the job gets hot the weights will bring it down to the correct line of the packing, and it will remain there until it is quite cold. Should the job be out in such a position that it is not practical to bring it to shape by means of weights, again find out where the fault is, and, if practical, which depends entirely on the shape of the job, apply the clamp method in the furnace, as explained in the case of closing in the turbine cylinder, or heat locally and bend to shape either by a hydraulic jack or screw chains, and anneal afterwards. The author has not yet encountered a casting that he has not been able to bring into shape by some means.

The Annealing of Castings.

All steel castings should be annealed to break down the casting-structures which cannot be removed except by reheating. The temperature varies according to the analysis. Carbon steel from 0.20 to 0.35 required 830 to 870 deg. C.; from 0.35 to 0.50 per cent. should be from 750 to 800 deg. C. Intricate castings of unequal thickness require very careful handling on account of the casting stresses which are set up during cooling; therefore, they must be reheated very carefully so as to maintain an even temperature, and when the required temperature is reached it should be held long enough to ensure that it is even throughout. Generally about 1½ hours is allowed per inch of thickness, after which the source of heat should be shut off and the furnace sealed up and left until quite cold. The danger point for a casting breaking or clinking is below 100 deg. C., very rarely before. When castings are all small and plain, work such as deck fittings, small railway work, pipes, small valves and general work, the castings can be heated up quickly, and once the satisfactory temperature is reached and maintained sufficiently long to soak through, they may be cooled down quite quickly, or in some cases may be pulled out of the furnace whilst hot, and no harm will be done once the casting-structure is removed.

The art of steel founding has made much progress during the last eight or ten years. To-day, there are large and intricate castings made successfully which very few foundries would care to attempt, say, ten years or so ago.

It would be better if the designer would consult the practical foundryman with regard to maintaining a fairly even thickness, avoiding thick metal in corners and diagonal ribs where possible, which often cause them to contract at cross purposes, which is liable either to put the casting in tension or to break it.

There are very few jobs, either large or small, which to-day cannot be made successfully as steel castings, if adequately studied. When made and cast in a practical manner, and properly heat-treated, they will give tests and working results equal in some respect to forgings made in similar material.

The Changes of Volume of Steels during Heat Treatment.

I.—Air Hardening Nickel-Chromium Steels.

By Leslie Aitchison, D.Met., B.Sc., and George Reginald Woodvine.

(Summary.)

Emphasising the importance of the alterations of volume that take place during the heating and cooling of the metal in the heat treatment of steel, the authors explain that it has been their intention to make some investigation of these critical volume changes, more particularly in respect to the more complex steels that are used so generally by modern engineers. The first series of tests have been carried out upon air-hardening nickel-chromium steels, chosen mainly because one of the authors has been engaged for some time upon an investigation of such steels, and particularly the changes that are produced in their mechanical properties when they are tempered at comparatively low temperatures. The physical changes undergone by air-hardening nickel-chromium steels at various tempering temperatures have formed a considerable part of the investigations in question, and the volume changes really formed one branch of the work. Having gone so far it was desirable that the examination of this type of steel should be continued, and as a result the work was extended further than might otherwise have been the case. It is felt that the results that have been obtained up to the present are of sufficient interest to warrant their publication (as an initial instalment) before the whole scheme of work has been brought to completion, and also possibly before the time is ripe for an attempt to give a complete explanation of the observed phenomena.

The eleven experiments made up to the present and described in the Paper may be summarised as demonstrating the following results:—

(1) That the expansion that should be produced at the critical range during the cooling from the hardening temperature is not completed during the slow cooling employed.

(2) That reheating to quite low temperatures induces a further expansion.

(3) That further reheating to low temperatures brings about a contraction.

(4) That prolonged heating at low temperatures induces still further contraction.

(5) That reheating to intermediate temperatures (300 to 500 deg. C.) induces a similar initial expansion and then a contraction.

(6) That reheating to 600 deg. C. induces a contraction.

(7) That the smaller initial expansion at the intermediate temperatures is likely to be the resultant of the expansion and contraction proceeding simultaneously.

(8) That the total contraction brought about at temperatures up to 200 deg. C. by repeated heating and cooling is less than that similarly produced at higher temperatures.

(9) That the maximum contraction brought about in any way at all the different temperatures is the same in amount.

This work is proceeding, and it is hoped that further reports may be presented in the near future, when an explanation of the observations and their practical bearings may be attempted.

Mr. Victor Stobie, of Dunston-on-Tyne, has recently transferred his membership from the Sheffield to the Newcastle Branch of the Institution of British Foundrymen.

Trade Talk.

ALEXANDER PETERS & COMPANY, LIMITED, nut and bolt manufacturers, have removed from North Claremont Street, to 35, Robertson Street, Glasgow.

J. J. THOMPSON & SONS, iron and steel and metal merchants, of 3, York Street, Manchester, have established a branch at 47, Exchange Buildings, Birmingham.

F. GILES & SONS, brassfounders, of 117, Scholefield Street, Birmingham, have appointed Grant-Chater, Limited, Traders' Bank Building, Toronto, as their Canadian agents.

F. W. WOODMAN & COMPANY, of 597, Sneinton Hill, Nottingham, have acquired the stock and patterns of the British Engineering & Electrical Company, Langford Street, Leek.

THE METROPOLITAN CARRIAGE, WAGON & FINANCE COMPANY, LIMITED, have secured the orders for 448 covered goods wagons for the Burma Railways and 270 ballast wagons for the South Indian Railway.

MR. A. C. MEYJES and Mr. R. F. Jones have established themselves in business at 55, Avenue Chambers, Southampton Row, London, W.C.1, as consulting engineers and agents, under the style of Charles Fennessy & Company.

DEVELOPMENTS are projected at the Gowanbank Iron Works, Falkirk. Plans have been passed and an early start will be made to reconstruct property at the works which was destroyed by fire.

H. C. SIDDENS & COMPANY, LIMITED, iron and steel merchants, of 77-82, Exchange Buildings, Birmingham, have established a London branch at 157, Palmerston House, 34, Old Broad Street, E.C.2.

THE imports of foreign iron ore at the Senhouse Dock at Maryport last month amounted to 3,800 tons, compared with 4,000 tons for the previous month. Last week 4,000 tons were imported.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, Egyptian House, 170, Piccadilly, London, W.1, have been appointed British and European agents for the Duff Manufacturing Company.

THE TOTAL OUTPUT of the Sunderland shipyards for the eight months of the present year is 19 vessels, aggregating 85,948 tons gross, compared with 15 vessels and 78,202 gross tons in the corresponding months of last year. The output for the first eight months of 1920 was 44 vessels and 201,143 gross tons.

CLAYTON WAGONS, LIMITED, of Lincoln, have secured a contract for 25 bogie rail and timber wagons for the metre-gauge lines of the Assam-Bengal Railway, 25 bogie rail wagons for the London and South-Western Railway, eight bogie passenger carriages for the Caledonian Railway, two bogie sleeping carriages for the Buenos Aires Midland Railway and five bogie carriage underframes and two four-wheeled carriage underframes for the Bengal-Nagpur Railway.

THE METHODS of the Disposal Board, which have lately been severely criticised by Rownson, Drew and Clydesdale, Limited, have now been brought to the notice of the Chancellor of the Exchequer as "Trustee of the public purse." In their letter to Sir Robert Horne, the company summarise their charges as below :—"(1) That the Disposal Board are involving the country in paying us approximately £50,000 compensation by refusing to give us that work for which we contracted, and to do which they are, in addition, keeping alive, at a heavy public expense, Disposal Board sections. (2) That the Disposal Board have sold at £24 6s. 8d., involving a loss of £1,500,000, quantities of brass on September 28, 1921, when they were aware that we had a contract in existence by which they were entitled to £35 per ton. (3) That the loss, based on contracts we held in March, 1921, of which the Disposal Board was fully aware, amounted to £3,600,000. (4) They in fact waited until it touched lowest, and then sold to the British Metals Corporation. (5) That quantities of other materials and stores which should have been sold by us, so avoiding compensation, have been retained by Disposal Board sections, so keeping up their sales returns as a justification for their continued existence. (6) That the sales by them have been thereby in competition with our own sales made on Disposal Board account, so losing heavily to the State. (7) That their system being chaotic, stores have not been dealt with for months and sometimes years after they have been available, many millions having been lost to the country. (8) That the Disposal Board can, by a commercial system which we are prepared to place before any committee of independent business men, at once save at least half a million sterling on existing estimates, and can, in addition, to all reasonable intents and purposes, be closed down within six months. It may be deemed that so far as charges Nos. 1, 2, 3, 4, 5, 6, and 7 are concerned, covering as they do losses already made, there is time for these to be investigated as Parliament wills. This, however, is not the case with charge No. 8, which deals with expenditure that can forthwith be avoided."

Company News.

James Joiner & Sons, Limited, Soudley, Newnham, Glos.—Capital £7,200 in £1 shares. Engineers.

Robert Crust, Limited, Bradford.—Capital £1,000. Electrical engineers. Directors: R. Crust, S. W. Hill and W. A. Toppin.

Cammell, Laird & Company, Limited.—Interim dividend, 2½ per cent., less tax, on 5 per cent. cumulative preference shares; no interim on ordinary.

Midland Shipbuilding & Trading Company, Limited, 10, Lime Street, London, E.C.3.—Capital £1,000 in £1 shares. Directors: E. E. Samuelsen, Karl Johansgate and A. V. Agius.

R. Kemp & Company, Limited.—Capital £15,000 in £1 shares (14,000 perference and 1,000 ordinary). Ship repairers. Permanent directors: Lt.-Com. A. H. J. Hamilton, Mrs. L. Hamilton, and R. Kemp.

Robinson & Nicholls, Limited, Loretto Wharf, Thames Road, Chiswick.—Capital £1,000. Founders, mechanical, electrical and general engineers, etc. Permanent directors: L. H. Robinson and H. Nicholls.

Ibbotson Brothers & Company, Limited.—Profit, £27,670; brought forward, £61,303; available surplus, £74,941; final dividend, 6s. per share for half-year ended June last (making 10 per cent. tax free for year); carried forward, £67,936.

John Simpkin, Limited, 18, Netherhall Road, Doncaster.—Capital £5,000 in £1 shares. Scrap merchants, spring manufacturers, etc. Directors: J. Simpkin, E. H. Shaw, J. H. M. Humble, J. Humble, C. G. Ramskir, and I. Woodhouse. Secretary: I. Woodhouse.

Hardy Patent Pick Company, Limited.—Brought forward, £15,483; net profit, £9,027; total, £24,510; preference dividend 7 per cent. for year; ordinary dividend 7 per cent. for year; depreciation of plant, etc., £5,000; depreciation of tools and patterns, £1,000; carry forward, £9,860.

Fletcher, Son & Fearnall, Limited.—Final ordinary dividend, 5 per cent., free of tax, making 10 per cent. for year; maintenance of premises and plant, £6,622; depreciation, £2,432; Government taxes, £29,035; investments depreciation reserve, £3,635; carried forward, £41,902.

Short Brothers, Limited, Pallion, Durham.—Capital £300,000 in £10 shares (15,000 preference and 15,000 ordinary), to acquire the shipyard and certain of the assets of, and to adopt an agreement with, Short Brothers, Limited. Permanent director and chairman: T. S. Short. Secretary: E. W. Short.

Elliott's Metal Company, Limited.—Profit, £82,225; brought forward, £23,349; available, £105,574; preference dividend, 5 per cent. per annum, less tax, £11,261; ordinary dividend, 3s. per shares, less tax (interim dividend, £22,149 already paid), £66,448; proportion of expenses of fusion with Muntz's Metal Company, Limited, £1,000; carry forward, £26,865.

Deaths.

MR. CHARLES GODFREY PHILLIPS, who met his death as the result of an accident while staying at Llandrindod Wells, was the eldest son of the late Mr. Charles D. Phillips, The Gaer, Newport. He was 48 years of age, and was educated at Christ Church, Brecon. Upon the death of his father, in October, 1912, he became joint manager of the large engineering business founded by his father under the style of Charles D. Phillips, Emlyn Engineering Works and Foundry, Newport, Mon., and continued to act in that capacity until a few months ago.

MR. RONALD LAIRD was found dead at his residence in Oxton on September 4, having been overcome by gas fumes. The deceased was at business on the previous day. As a young man, Mr. Ronald Laird did not enjoy robust health, and shortly after finishing his education he had to spend some years in the South of England. Returning North, he commenced his business career, and in November, 1915, was appointed to succeed the late Mr. James Burton as Liverpool representative of Cammell, Laird & Company, Limited. He was a direct descendant of the late Mr. John Laird, founder of the firm.

MR. J. AMOS LLOYD, managing director of John Brotherton, Limited, Wolverhampton, died on September 2 at his residence at Compton, near Wolverhampton. The late Mr. J. Amos Lloyd, who came of an old Staffordshire family, was born at Pelsall in 1860. An early business training in the iron and steel trades fitted him for a secretarial position, which he took up at John Brotherton, Limited, Wolverhampton, thirty years ago. From secretary he rose to managing director, and was actively engaged in business until about a month ago. He became a member of the Council of the Wolverhampton Chamber of Commerce in 1901, and he was made president in 1906. From 1916-1919 he was again elected president, and was a member of the executive council since 1917.

IRON AND STEEL MARKETS.

Pig-iron.

Markets all round during the week just closed appeared to have recovered some degree of firmness, and with an under-current of renewed activity the outlook may certainly be claimed as more encouraging than has been experienced for some time past. This improvement, however, cannot be attributed to an expansion of home demand, which continues of disappointing volume, but may probably be credited to an increase of exports of pig consequent upon domestic industrial troubles in the United States, where the miners' and railwaymen's disputes have caused a temporary suspension of iron furnace outputs. So far, Midland ironmasters have not been so much affected by these conditions, but the demand for export iron in the North-East and Scottish markets has enabled some of the Derbyshire and South Staffordshire makers to dispose of surplus stock on fairly favourable terms. The difficulty in the latter markets is that buyers continue to restrict their purchases to comparatively small parcels for immediate requirements, very few transactions on forward account being reported. Some indication of the more hopeful prospect for the trade is found in preparations now going forward for increased production, additional furnaces being re-lighted in some of the principal centres of the industry.

In the Tees-side area the feature of the market is the advance in prices of Cleveland iron in consequence of the American orders. Compared with normal times, of course, these orders are not heavy, but coming at a time when production has been limited to the smallest possible, it has naturally created some scarcity of iron, and the better qualities are now practically unprocurable for prompt delivery. Values have accordingly been advanced by at least 2s. 6d. per ton, but this can only be of a temporary character and dependent upon the length of the American demand. Consequently at last week's market prompt iron was unobtainable, and No. 3 quality was strong at 90s., or 2s. 6d. above the previous week's figure. For No. 1 and silicious, which have been extremely scarce for a long time past, 97s. 6d. was named, and No. 4 foundry advanced to 87s. 6d., No. 4 forge being about 85s., and mottled and white 80s. to 82s.

In the Cumberland and North Lancashire hematite pig-iron market, there is at last some prospect of an additional furnace or two being lighted. Only nine furnaces—six in Cumberland and three in North Lancashire—are now blowing. But the make is being fully absorbed, and, what is more, the stocks lying in the works' yards are being fast depleted. Competition here is exceedingly keen, and the quotation of Bessemer mixed numbers at £5 5s. per ton delivered at Glasgow and Sheffield is only nominal. In actual fact, the price is a few shillings below that figure, and thus the prediction that iron would fall to £4 10s. per ton at works before winter has come true. In the North-East Coast market the general level of business has been better. Iron is being got away in moderate lots to Wales and the Continent, and one or two makers have been helped by sales to America. At last week's market sellers developed a rather firmer attitude, the majority declining to name less than 90s. for East Coast mixed numbers. But there was still a possibility of shading this figure for substantial business. The premium for No. 1 stands at 6d. per ton.

The August shipments from Middlesbrough (including 2,513 tons from Skinningrove) amounted to 37,972 tons, compared with 35,426 tons in July, an increase of 2,546 tons. Shipments to the United States were again an outstanding feature, amounting to 9,862 tons, as against 5,825 tons in July, an increase of 4,037 tons. Italy was the next largest buyer with 4,023 tons, as against 4,470 tons. Belgium took 3,096 tons, Germany 2,680 tons, France 1,420 tons, Denmark 1,276 tons, and B.W. Indies 1,000 tons. Coastwise, 5,060 tons went to South Wales and 3,050 tons to Scotland.

Finished Iron.

The markets for finished materials, although better attended of late, do not as yet reflect any striking improvement in general business, due it must be assumed to the uncertainty of price movements, and a lack of confidence as to the trend of future demand on the part of buyers, both at home and abroad. In the South Staffordshire area there are still many works standing idle, or only partially employed, and there seems little prospect of an improvement in this direction until manufacturers' overhead costs can be reduced. Among the chief contributory factors in this connection is unquestionably the high cost of rail transport for both raw and finished material, which inflicts a heavy handicap on Midland iron manufacturers, who find themselves at a serious disadvantage

(*Continued on page* 230.)

MACHINERY.

(*Continued from page 18.*)

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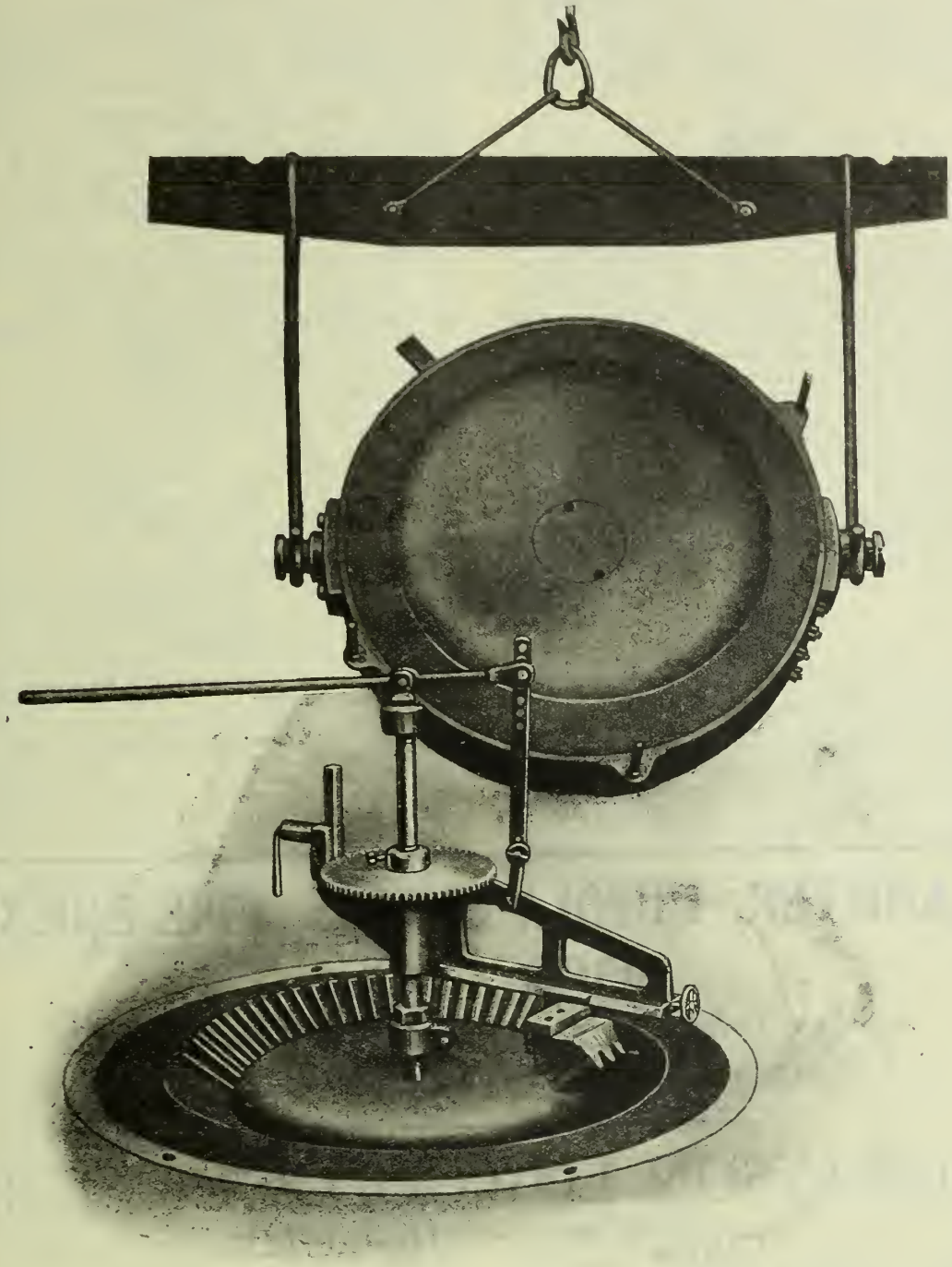
The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.—*Cont. from page 228.*

in competing for export business with producers having seaboard facilities. In the bar-iron section makers of marked qualities report an average demand, but with only limited forward buying, owing, it is surmised, to an erroneous impression that a further reduction in values is imminent. A similar idea appears to prevail with regard to crown bars, for which £10 12s. 6d. is quoted, although it is understood that that price is unremunerative. Nut and bolt qualities are only in moderate demand at about previous rates, while inquiries for gas strip are by no means up to the usual average,

Steel.

Conditions in many branches of the steel trade continue to make slow but steady progress towards recovery from the recent depression, and it is generally admitted that the influx of orders and inquiries is coming in satisfactory volume. At Sheffield the outstanding feature is the call for the cheaper classes of steel, in which local manufacturers are able to compete with Continental producers. For high-speed and other high-class steels there is scarcely any inquiry, and such requirement as there is is mostly met from surplus war stocks. Basic billets are selling fairly freely, but acid qualities are very quiet. Indications of the strength or weakness of the steel industry are also to be found in the position of the ferro-alloy market, from which is learnt that while the demand for ferro-chrome in all grades has been more brisk, prices on the whole have not tended to hardening, and it would appear the demand is mainly for immediate requirements and does not point to any forward business. Ferro-silicon has been stagnant, whilst most of the other alloys have been more or less dormant.

Scrap.

Corresponding conditions to those already outlined in the pig-iron trade are evidenced in the markets for scrap, and although the volume of business reported is only comparatively small, the demand all round indicates a steady improvement in consumptive requirements. At Middlesbrough there is some shortage of heavy steel scrap to suitable specifications, and a steady demand is developing, with the result that 65s. per ton delivered works is now firmly held. Steel turnings and c.i. borings are also scarce, and realise 48s. to 49s. per ton delivered.

Metals.

Copper.—During the past week values for standard metal have been at consistent strength, and in trade circles the opinion is expressed that prices should maintain their present levels over, at all events, the end of the quarter. Evidence favouring this view is the resumption of influential support, withheld from the market for some time past, while the consumptive demand at home and on the Continent also shows an improvement. Current quotations :—*Cash* : Wednesday, £63; Thursday, £63 2s. 6d.; Friday, £63 2s. 6d.; Monday, £63; Tuesday, £63 2s. 6d. *Three Months* : Wednesday, £63 7s. 6d.: Thursday, £63 10s.; Friday, £63 10s.: Monday, £63 7s. 6d.; Tuesday, £63 10s.

Tin.—Home consumers' demands of late have been by no means brisk, but there has been a fair volume of speculative dealings in standard tin, while support for the market has also been forthcoming from America, where the tinplate trade is active. The usual monthly statistics for August show an increase in the visible supplies, but although this was anticipated, the excess was not expected to amount to such a large tonnage. Sentiment, however, has not been greatly affected thereby. Meanwhile the East has sold fair quantities at prices following the London market. Quotations for 65 per cent. Bolivian ores range from £93 to £95 per ton. Current quotations :—*Cash* : Wednesday, £159 10s.; Thursday, £159 15s.; Friday, £159 12s. 6d.; Monday, £159 5s.: Tuesday, £158 12s. 6d. *Three Months* : Wednesday, £163 7s. 6d.; Thursday, £160 5s.; Friday, £160 2s. 6d.; Monday, £159 15s.; Tuesday, £159 10s.

Spelter.—Some fluctuations in values of this metal have been noted of late, but these have been confined in a narrow range, and the market generally has been fairly steady. Current quotations :—*Ordinary* : Wednesday, £31 7s. 6d.; Thursday, £31 7s. 6d.; Friday, £31 10s.; Monday, £31 10s.; Tuesday, £31 10s.

Lead.—With some improvement in home consumptive demand, soft foreign pig has been firm and steady, with values held at recent levels. Stocks of lead on September 1 are returned at 686 tons, an increase of 451 tons on the previous month's total, but at the same time these remain practically negligible. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 12s. 6d.; Thursday, £24 12s. 6d.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24 10s.

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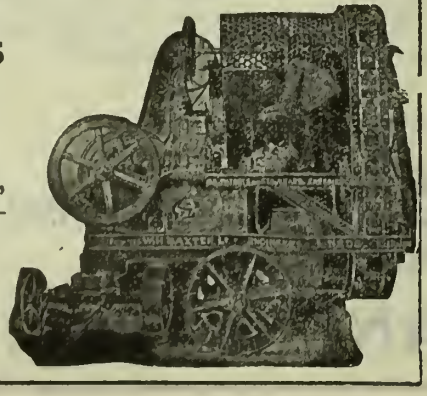

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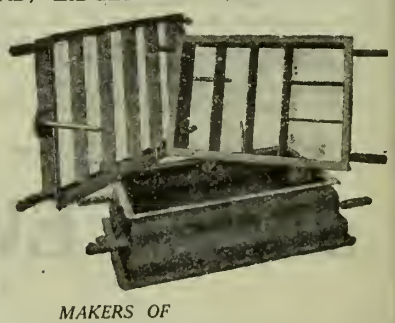

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THE

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Contents.

	PAGE
Porosity in Cast Iron	231
London Foundry Classes	232
Correspondence	232
The Price of German Castings	232
A Note on Venting	232
Birmingham Metallurgical Society	232
An Apprenticeship Course in Foundry Practice—X.	233
American Pig-iron Output, 1922	235
Foundry Refractories	236
The History of Loam Moulding in the Liége District	239
Paris 1923 International Congress	240
Society of German Foundrymen	240
The Reichert Metallurgical Microscope	241
Belts for Pattern Shop Machines	244
An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands	245
Malleable Iron Melting by Powdered Coal	246
Institution of British Foundrymen	247
Aluminium Alloy Pistons	248
Trade Talk	249
British Electric Furnace Prospects	249
Iron and Steel Output in August	249
Company News	250
Gazette	250
Personal	250
Contracts Open	250
Deaths	250
Iron and Steel Markets	251
New Process of Finishing Welded Pipes	252

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Porosity in Cast Iron.

As a basis for discussion, an article in the September number of *La Fonderie Moderne*, by Mons. Marcel Didier, on "Factors Influencing the Porosity of Cast Iron and How to Avoid it," presents much of interest.

Mons. Didier points out that porosity is due to the evil influence of gas, which penetrates the liquid metal or which is formed there through various reactions. These gases, he states, are principally composed of oxygen, nitrogen, carbon monoxide, and they naturally have a tendency to rise to the surface of the liquid metal in order to escape into the atmosphere, but often the iron freezes before the gases are completely eliminated. In the portion last to freeze there is a probability of finding numerous pockets or blowholes which are associated with large graphite areas or a highly-crystalline metallic structure due to the length of time taken to cool. This structure possesses poor cohesiveness owing to the large size of the grains and to the graphite plates which separate them.

It thus seems necessary to have a metal of normal cohesiveness, that is to say, a non-porous iron, in order to prevent the formation of large graphite plates and crystalline zones.

The following factors influence the porosity of cast iron: (1) Casting temperature; (2) crystallisation; (3) chemical composition; and (4) heat-treatment. Dealing with casting temperature, Mons. Didier insists that this is the principal factor in causing porosity, and adds that the hotter the metal the less chance there is of blowholes. Additionally slag inclusions, on account of the low density, have a chance to rise to the surface. A high temperature permits of the metal being in a state of chemical equilibrium, and prevents harmful internal tension.

The second factor, crystallisation, is dealt with by stating that when liquid iron cools the planes of crystallisation group themselves at right-angles to the walls of the mould. An extreme variation in contour of the walls has a profound influence on the crystalline system, and can produce irregularity associated with lines of least resistance. For this reason sharp angles and projections should be eliminated or reduced to a minimum. There is no exception to this rule. Large variations of thickness during cooling set up internal tensions, resulting in pulls and draws.

Of the elements entering into the chemical composition of iron, perhaps silicon has the greatest influence on the fluidity and hardness. As silicon facilitates the formation of graphite, incorporation should be kept within reasonable limits. Phosphorus increases fluidity of cast iron, lessens contraction, and reduces the likelihood of blowholes and inclusions. But, on the other hand, it produces large grain, with which is associated weakness and porosity. Up to 0.08 no bad effect should be experienced. Manganese hardens iron: it has, contrary to silicon, the property of hindering the formation of graphite. Chromium and titanium increase the hardness, give that fine grain so desirable in cast iron.

As to heat-treatment, it is stated that despite all precautions that may be taken during cooling, internal tensions are produced due to differences in the rate of cooling. To destroy these a reheating followed by slow cooling is necessary. This heat-treatment does not only break down the tensions, but also reduces the passive resistances which act against the homogeniety of the iron. This is very important when the castings have to be machined.

Numerous methods have been devised for closing up porous places, but a great number are more or less impirical. For instance, some foundries allow porous castings to soak for a period in a tank of urine. Mons. Didier points out that he does not wish to discuss the results obtained, but states that the process is scarcely scientific nor yet hygienic. He is of opinion that the best method is to copper porous castings by the electrolysis of a copper-sulphate solution. This process has the advantage of being simple, requires no special installation, cheap and within the scope of all foundrymen. It is noteworthy that the deposit of copper adheres quite firmly. The penetration into the pores can be helped by electrolysing under pressure.

We are of opinion that Mons. Didier has missed out one of the principal factors, that is, gating and running; but, as stated, his four factors certainly form an excellent base from which to tackle the proposition of porosity.

London Foundry Classes.

In the Department of Metallurgy at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3, a special course of instruction on "Foundry Practice" will be given during the Autumn and Lent terms by Mr. G. Patchin, A.R.S.M., M.I.M.M., and Mr. A. F. Gibbs.

The course will consist of lectures and demonstrations accompanied by practical work in moulding, core-making, and casting. The instruction will be of special value to metallurgists and those engaged in engineering and foundry work. The opening lecture of the course will be given on Monday, September 25, at 7 p.m.

The syllabus includes: Moulding sands; moulding boxes and tools; methods of moulding; cores and core-making; stoves and furnaces; temperature control; furnace tools; metals and alloys used—ferrous and non-ferrous—properties and composition; calculation of mixtures; cleaning and trimming of castings; annealing; faults—blowholes, cold shuts, porosity and drawing, scabbing, etc.; detection of faults—use of the microscope; general arrangement and design of the foundry; costing.

The laboratory work will include testing of moulding sands, measurement of temperatures, preparation of moulds and cores, casting in iron, brass, bronze, aluminium alloys, etc.

As the accommodation for practical work is limited, students may be admitted to the lectures only provided they can give satisfactory evidence of practical experience.

The fees for students resident in the administrative County of London and in the County of Middlesex are 20s. for lectures only, and for lectures and two evenings a week practical work, 30s.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

SMALL RUNNERS AND SOUND CASTINGS.

To the Editor of The Foundry Trade Journal.

Sir,—With reference to your footnote, the idea that I intended to convey was that owing to the tendeney of a small channel or runner to freeze quicker than a large runner, hotter metal *must* be used in the first place.

Secondly, with a large runner, the parts of the mould adjacent to that runner are receiving fresh supplies of heat in mass, which heat up these parts quickly to a temperature never possible with a small stream of metal. This tendency of the large runner to superheat the mould at the point where it enters, producing either open or spongy metal, and feeding or other methods must be made to counteract the effects. This action of the runner is specially noticeable in the case of small but comparatively weighty flywheels. If, for convenience or otherwise, the metal is allowed to enter by the rim, by the greater difficulty in balancing them, this being due to the metal of the casting near the runner being less dense than in other parts of the casting.

Regarding the extraction of heat from a small channel, although the surface area of a small channel comparing a ½ in. sq. channel with a 1 in. sq. runner, being respectively 2 in. and 4 in., the smaller channel has only ¼ sq. in. of sectional area, as against 1 sq. in. of sectional area in the larger channel, so that *proportionately* the small channel has double the wall or surface area of the larger one. In other words, although the actual wall area is as 2:4, the capacity is as 1:4. This tendency of a small runner to freeze is recognised in making light castings, when a large runner would be dangerous to remove, by the provision of heat retainers similar to those referred to by the writer, and placed quite close to the casting. Although the writer drew attention to the fact several years ago, it is not common knowledge, so far as moulders are concerned, that ½ in. square is not the same as ½ sq. in., a fact that has led to a few errors in some foundries.

Assuming the extraction of heat in the case of ½ in. sq. and 1 in. sq. were relatively equal, there would still, at some period during solidification, be a central portion approximately ½ in. sq. (still more or less fluid and surrounded by a wall of already solidified metal) in the case of the 1 in. sq. runner.—Yours, etc.,

"Ecossais."

The Price of German Castings.

According to a communication sent by the Commercial Secretary at Cologne, forwarded to the Department of Overseas Trade, the German Fittings Association has increased the surcharge for malleable castings with effect as from August 23 to 3,800 per cent. The prices for wrought-iron fittings are increased from the same day by 50 per cent. net. The Association of German Iron Foundries, Giessereiverband, has increased the prices for castings by 70 per cent. as from September 1. The prices for cast-iron socket pipes and pipe fittings were increased by 75 per cent., for cast-iron fall pipes also by 75 per cent.

Pig-Iron.—The pig-iron prices fixed at the last meeting of the Pig-Iron Committee of the Eisenwirtschaftsbund for deliveries as from September 1, now that the coke price increase has been taken into consideration, are as follows:—Hematite, 29,784; steel-making pig, low in copper, 29,116; foundry pig-iron I., 25,575; foundry pig-iron III., 25,505; foundry pig-iron, Luxemburg quality, 23,818; Siegerland steel-making pig, 27,543; and spiegeleisen, 8-10 per cent., 30,133 Mks. per ton.

A Note on Venting.

By J. S. Shepherd.

The writer recently had some toothwheels castings to make, and the foreman lay stress with his instructions to use ground sand. His orders were carried out, but the results were a failure; the sand would draw up with the tooth. Eventually the following procedure was successfully adopted: Equal quantities of ordinary facing sand was mixed with black sand. After placing the moulding box in position upon the odd side or pattern plate, sieve the facing sand upon the pattern sufficiently to cover it, then fill up the box with black sand and ram round the pattern. Fill in more sand and ram again until the box is ready to flat-ram, but instead of using the flat rammer, pat the sand down with the hands and then strike off in the usual way. This is the point where the writer claims that the trouble arises. Before turning over the box—or, if on a moulding machine, drawing the pattern plate—push a tube through the back of the mould down to the core print, and withdraw the sand, any size that is smaller in diameter than the print of the core. This allows the air to get in the mould as the pattern is being drawn, and prevents the formation of a vacuum, which is, in the writer's opinion, the cause of the bad draw. The same applies to core-making. If pattern-makers would bore a small hole in any print or position where the core-maker could easily fill in after drawing the box, there would only be the deadweight and friction of the box to overcome.

Although many construct collapsible coreboxes and patterns, they are not necessarily an advantage, as the loose pieces may warp or get lost, and the screwed variety are constantly requiring fresh holes and screws.

Birmingham Metallurgical Society.

The opening meeting will be held at the Chamber of Commerce, Birmingham, on Wednesday evening, October 4, at 7.15 p.m., when the President, Mr. A. J. G. Smout, will deliver his inaugural address on "Waste and Inefficiency in the Metal Industry." This will be followed at regular intervals to the end of April with papers by some of the leading authorities in the iron and steel and metal industries. Copies of the syllabus may be obtained on application to the Secretary of the Society, Chamber of Commerce Buildings.

An Apprenticeship Course in Foundry Practice—X.

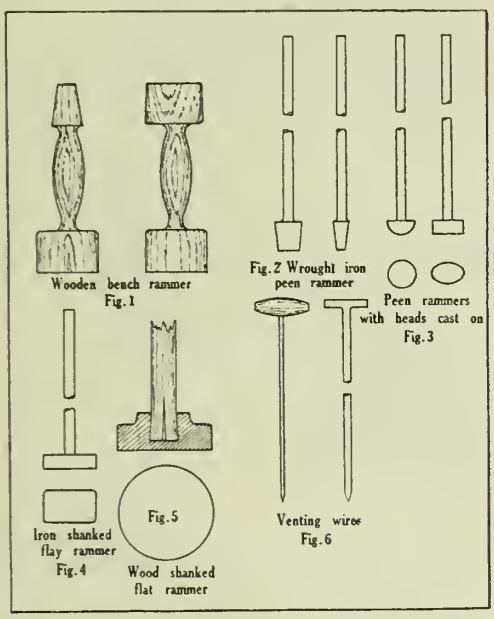
By Ben Shaw and James Edgar.

RAMMING AND VENTING SAND MOULDS.

With the exception of those that are made in loam, moulds are generally formed by consolidating the sand about the pattern. The process is known as ramming. This compression of the sand is essential in order that the mould will have body and strength to maintain the shape given to it on the withdrawal of the pattern and to resist the pressure of the metal.

Relative Density.

The degree of density given to the sand has an important bearing on the success of the resulting casting, and it must be varied to suit the design of the casting to be made, the kind of metal used, and the class of mould to be formed. Moulds for castings which are deep should be rammed harder towards the bottom to withstand the greater pressure of the metal, and, as a rule, the sand must be rammed more lightly for thin castings to enable air and gases generated to escape readily without injury to the casting.



When the casting is composed of thick sections the sand can be rammed harder, and, as the metal remains fluid for a longer period, any slight back pressure of gases upon the surface is compensated by the pressure of the metal. The ramming is varied in some moulds when the contraction of the metal to be cast in them is likely to be impeded, thus, though the face of the mould may be well rammed, it may be advisable to reduce the density of the sand behind it. Generally speaking, cast metals are "hot short," that is, they are weak when hot and castings are easily fractured in that condition; and, as some metals, such as cast steel and aluminium, contract quickly immediately following the point of solidification, it is necessary to ram lightly so that the contracting influence of the metal will be greater than the resistance offered by the mould. But stronger moulds are needed for steel than for aluminium, because it is a heavier metal, and, in a liquid state, it exerts relatively more pressure; therefore, moulds to receive aluminium should be lightly rammed, while those for steel should be well rammed, and precautions, other than ramming, should be taken to weaken the mould when the design of the casting demands it. Moulds for brass need not be rammed very hard, although more than is necessary for aluminium; but more care is necessary for bronzes, particularly phosphor bronzes, because they are more searching in their character and more readily penetrate the interstices between the sand grains when they are in a fluid state. For such metals the moulds should be more dense at the face, but only the face sand, the backing sand being rammed lighter so that the mould will vent better. There is room for more scope in the ramming of moulds to receive cast iron because it expands at the point of solidification and it does not contract so much as the metals previously mentioned. Under similar conditions, and with slight modifications, such as have been referred to, we consider that the varying density between moulds for varying metals should be in the following order—aluminium, brass, bronze, cast iron, and cast steel, the former being the more lightly rammed.

Ramming Green and Dry Sand Moulds.

The class of mould that is being prepared has a very important bearing on the degree of density of the sand. Thus greater care and relatively lighter ramming are necessary in the preparation of moulds in green sand than in dry sand. A considerable amount of steam is generated in green-sand moulds, and if the sand is tightly packed the pore space is reduced and the permeability of the mould decreased, with the result that the metal may offer less resistance to its escape than the mould, with, generally, disastrous results to the casting. In dry-sand moulding however, the bulk of the moisture is evaporated, leaving little steam to be released. When the mould is dried it is left more porous. A dry-sand mould can therefore be rammed to greater density than a green-sand mould, other conditions being equal.

Ramming Needs Experience.

Considerable skill is necessary to ram moulds successfully. To the uninitiated it looks a comparatively simple operation, and apparently anyone could ram a mould; but everyone cannot vary the degree of density required to suit the work that is being moulded, which only experience can determine, particularly for green-sand moulds. Practice, too, is needed to acquire what might be termed the sense of touch. A dry-sand moulder transferred to green-sand work generally experiences difficulty with the ramming of the sand, and some time may elapse before he acquires the necessary manipulative skill; that is one of the reasons for making dry-sand and green-sand moulding distinct branches. As a rule more experience is necessary for ramming green-sand moulds, but it must be remembered that difficult work is passed on to the dry-sand moulder because of the greater risk in producing a good, sound casting in green sand; thus, there are other factors to be considered before the relative skill required in these branches of moulding can be given their correct perspective.

In machine-moulding the sand is, to a considerable extent, consolidated by mechanical power with which we shall deal when considering machine-moulding; but, in the formation of the general run of work, hand ramming is resorted to.

Ramming Tools.

The tools used for compressing the sand are termed rammers, and they are divided into two types, though there are many variations of each type. They are known as the peen, pegging, or pin rammer and the flat rammer, and in large work the moulder makes use of his feet for compressing the sand. For ordinary bench work, particularly in the brass foundry, a wooden hand rammer is frequently employed, such as is shown in Fig. 1. Both ends are used, that which is chamfered off being the peen rammer, the other being the flat rammer. Iron rammers are more frequently used for floor work, and their lengths vary according to whether the ramming is done by the moulder kneeling or standing. Usually peen rammers are made from $\frac{3}{4}$-in. or $\frac{7}{8}$-in. round iron with one end jumped up or having a bit welded on to form the peen, Fig. 2, although

some have the peen cast on, as shown in Fig. 3. It is the more general practice for flat rammers to be cast on shanks or handles, and the metal is usually rectangular or circular in shape as in Fig. 4. Wood shanks may be used instead of iron, but they should not penetrate the face of the rammer; instead, the rammer should have a tapered hole cast in it and the handle secured with a secret wedge, as in Fig. 5. There are other forms of rammers in use, some being tipped with rubber to prevent damage to the patterns should they come in contact with them, while many pneumatic rammers operated by hand are in use. Ramming a mould, especially if of large size, is undoubtedly a laborious job, and mechanical rammers are an acquisition when the necessary facilities are available for installing them. Pneumatic rammers are easily controlled, and varying pressures can be applied according to the needs of the work, to an extent comparable with hand ramming. When hand ramming must be resorted to, rammers, particularly flat rammers, should be warmed to prevent sand adhering to them during the process, otherwise the labour involved is increased.

Method in Ramming.

In the process of ramming a mould the peen rammer is used first, and its use is continued to compress the sand following the contour of the pattern, and a flat rammer used for the backing sand; but for shallow moulds, which have the minimum of support, the peen rammer should be used completely to ram up the box part, the flat rammer only being used after the box is full and before the surplus sand has been strickled off. This is necessary, because the sand is added gradually, and each addition is rammed separately, and the peen rammer being smaller is less likely to form a joint from which the next layer of sand may separate than a flat rammer. It must be remembered that, although the peen rammer should be used as near to the vertical sides of a pattern as is possible, without touching the pattern, for some classes of work, the operation needs considerable care to obtain a regular density; hard places on the mould surface will cause the casting to scab, due to the resistance offered to the escape of gases, while soft places will give under the pressure of the metal and show swells on the casting. Generally the rammer should be applied about an inch or more from the pattern, the compression of the sand on the face of the mould is then more likely to be regular, an important consideration with all sand moulds, but more especially with green-sand moulds.

Venting.

The density of the mould should be such that, besides having strength to resist the momentum and pressure of the molten metal, it is sufficiently open in texture to enable gases to escape quickly without detriment to the casting. This combination of strength and permeability of the mould is most difficult to obtain in green-sand work, and as the mould must be rammed to suit the possible pressure of the metal, the porosity of the sand is assisted by artificial means and is known as venting. The venting of moulds is capable of very wide interpretation, but, for the time being, we purpose considering it in connection with sand-moulding only. The escape of air and gases from a mould must be provided for, and many waster castings can be traced to the ineffectual provision made. Not only do vents in a mould provide a means of escape, but they determine the direction in which the escape is to be made because the current of escaping steam or other gases along the vents tends to draw similar gases through the pores of the sand in the same direction. Vents have been referred to as the safety valves of the mould, and this very aptly describes their value.

Vent Wires.

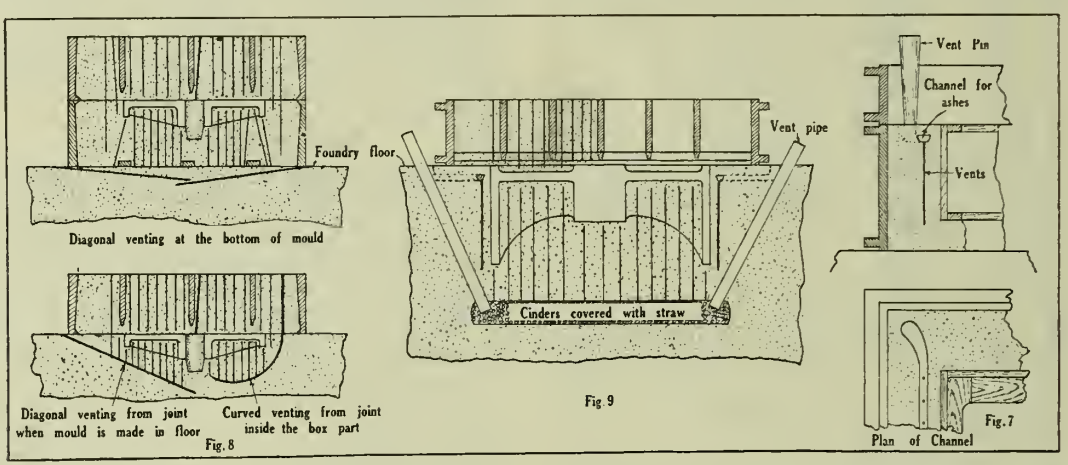
In small moulds the vents are usually made by thin wire about $\frac{1}{8}$-in. dia., while as the size increases $\frac{1}{4}$-in. or even $\frac{1}{2}$-in. dia. vent wires may be used. The small vent wire is about 12 in. long, having, generally, a wood handle; the larger type is longer with an iron T handle, both of which are illustrated in Fig. 6. Venting, however, is not confined to the use of vent wires; wood or straw, rope, hay, ashes, or waxed string may be employed according to the shape and size of the casting to be made.

The Use of the Vent Wire.

Generally speaking, more venting is necessary on the top of a mould than the bottom, because the pressure of the metal is less and not so likely to overcome the resistance of gases. When moulds are small and are made in boxes the vent wire should be applied from the outside after the pattern has been rammed up and before it is withdrawn. The vent wire need not come in contact with the pattern, as it destroys the pattern, and they are of little value if the metal is sufficiently fluid to fill them; if they are within $\frac{1}{2}$ in. or $\frac{3}{4}$ in. of the pattern they will suffice, because the influence of the molten metal on the backing sand causes the vents to draw gases from the face of the mould and through the intervening thickness of sand. When venting is done from both top and bottom of the mould it should be laid on a softened bed of sand to be cast to allow the free escape of gases through the bottom. Some moulds need to be vented from the joint of the mould as well as from the top. This is best accomplished by ramming up in the usual way and venting the cope from the top, and when the cope has been removed, the vent wire is used from the joint into the drag about 1 in. to 2 in. away from the pattern and at intervals of from 2 in. to 3 in. Frequently these vents are connected on the joint and directed to the edges of the box part. When the drag part is made in the foundry floor it must be vented from the joint, though sometimes it is done from outside the cope box.

Venting Deep Moulds.

Deep moulds should have larger vents, either directed downwards or upwards as circumstances require, and small vents may be used to direct the gases towards the larger vents. The larger vents should be connected by means of a channel



cut in the sand and preferably just below the top joint, as shown in Fig. 7. Some moulders prefer to make the connecting channel on the top joint, but metal is more likely to find an entrance and probably fill the vents and be a source of danger. The channel should be carried to a convenient corner of the box either to provide an exit from the side of the box, or, if that is impossible, in order to ram a vent stick in a convenient part of the cope. The channel should be filled with ashes—sometimes straw rope is used—and sand rammed over the top to form the joint. When the cope box has been located a vent stick should be introduced to connect the vent with outside. This is drawn when the cope is made. It is important to make sure that the connection is clear, and when the cope is finally lowered into position the vent should be loosely filled with straw, and at the time of casting it should be fired.

Wax Vents.

The use of wax vents is more applicable to cores of an intricate nature, but occasionally there is a need for their use in parts of moulds which would be weakened by the use of the vent wire, or so difficult of access that they could not be vented with any degree of security otherwise than by introducing wax vents. Wax wire is used for this purpose, either composed wholly of wax or of wax having a centre of string. The heat of the hand is sufficient to make it pliable without breaking or cracking, and in that condition it can be introduced at suitable places during the time of ramming up a mould. They are associated with dry-sand moulding, the heat given to them when being dried melting the wax, which is absorbed by the surrounding sand, and thus venting the mould. The wax wire should be connected to the main vents or so directed that free exits for gases is assured.

Igniting Escaping Gases.

Firing the gases escaping from vents during the time of pouring prevents an explosion which will take place to a more or less extent when the gas does take fire from the heat of the mould. The gas is similar to the dreaded fire-damp of coal mines, and is known as carbonic oxide or carbon monoxide (CO). When an explosion is allowed to occur about the mould it may affect the casting, especially in a greensand mould. Parts of the mould may be shaken out of position either before the mould has been completely filled or before the metal solidifies, and however small the disturbance may be, it may result in a waster casting.

Venting Flat Moulds.

When the mould is flat diagonal vents should be made from the joint, and the vent wire may be bent in order to direct it towards the underside of the pattern, or side vents may be used according to whether the mould is made in or above the foundry floor, and after the pattern is removed, connecting vents should be made through the face of the mould as long as care is taken in sleeking sand in the vents at the face to prevent metal entering. This method of venting is illustrated in Fig. 8. Generally, when the foundry floor is used for large flat work, or when the underside is recessed, it is better to make a cinder bed under the mould, forming an escape chamber to which vents are directed, and either ramming up vent sticks connecting the chamber with the outside or introducing pipes through which the gases will escape. An example is illustrated in Fig. 9 which shows the use of a cinder bed for venting purposes. In this case the drag is vented downwards, but the cope is vented direct through the top. The depth of a cinder bed should be about 3 in. or 4 in., and in some cases more, depending upon the amount of concavity of the required casting; in any case, it should not be less than 3 in., and the cinders used should be riddled to exclude fine ashes. It is of course necessary to prepare this cinder bed before the pattern is finally located and the contact made with the pipes or vent sticks. The former should be plugged with waste or straw to prevent sand entering while making the mould. The top of the chamber should be from 3 in. to 6 in. below the lowest part of the pattern, depending upon the size of the work, and the vents are made into it from the mould surface after the pattern has been withdrawn, as in Fig. 9. After cinders have been introduced into the chamber, it is a good practice to cover it with a layer of straw before the covering sand is applied, so that sand will be excluded from the cinder bed.

General Considerations.

It must be remembered that a fine sand requires more venting than a coarse sand, as also does the moulds for thin castings; and when hard ramming is necessary special attention must be given to the venting because the metal is not likely to lie quietly against a hard-rammed surface unless the gases which would prevent it doing so have a quick means of escape through the sand. The same may be said with reference to sand which is too damp in green-sand moulding or too strong in dry-sand moulding. The vents made about the vertical sides of a deep mould should be parallel with the sides and not directed towards them, as vents may penetrate into the mould and leave small, weak portions of sand which are likely to be blown into the mould if they are overlooked by the pressure of escaping gases. In the higher parts of a mould vents may penetrate the surface; in some cases it is advantageous that they should do so, notably in small castings of brass, when it is either not possible or desirable to have risers, a needle vent may be used to free the metal from pressure so that it will rise and fill the mould. This precaution is not exceptional to brasses or bronzes, it is also applicable to steel, aluminium, and, to a certain extent, cast iron. A misrun may be caused through the head of metal being insufficient or the metal may not be hot enough; in either case, however, needle vents assist the complete filling of the mould by freeing the metal from pressure. The brasses and bronzes have less fluidity; they set quickly, and are affected to a greater extent than other metals by the back pressure of gases if there is not sufficient head on the metal. Live metal adjusts itself more readily to any temporary back pressure from gases than a metal low in temperature, because it retains its fluidity longer. The successful production of castings depends largely upon what might almost be termed minor details in the formation of their moulds, for which the moulder is entirely responsible, and not the least of these is ramming and venting the mould to suit the varying conditions involved.

American Pig-Iron Output, 1922.

According to Special Statistical Bulletin No. 4, 1922, issued by the American Iron and Steel Institute, the output of pig-iron in the United States during the first half of 1922 (as compared with the corresponding half of 1921 in brackets) was as follows, in long tons of 2,240 lbs., according to the grades:—Basic, 6,389,876 (4,504,431); Bessemer and low-phosphorus pig-iron, 3,512,604 (3,280,072); foundry iron and ferro-silicon, 1,629,229 (1,375,399); malleable pig-iron, 427,998 (165,522); forge, 102,884 (48,937); spiegeleisen and ferro-manganese, 96,555 (136,269); all other grades, 31,865 (20,351); total iron made for sale or for use, 12,191,011 (9,530,981) long tons.

According to the fuel used, the half-yearly outputs were as follows:—Coke pig-iron, including ferro-alloys made with or without coke by electricity, 12,106,225 (9,448,223); anthracite, including anthracite mixed with coke, nil (12,823); charcoal iron, 84,786 (69,935) tons.

The total number of furnaces in blast on June 30 last was 201 out of a total of 450, as against 125 in blast on December 31, 1921.

The North Somerset Engineering Company, Limited, is being wound up voluntarily. Mr. D. Owen, 47, Milsom Street, Bath, has been appointed liquidator.

Foundry Refractories.*

By H. Winterton.

Dr. Stansbie, in *Iron and Steel*, defines refractory materials used for metallurgical purposes as "bodies that can be exposed to the furnace temperatures for which they are used without softening or disintegration." This sums up in a single sentence the secret of "Foundry Refractories." The author has for many years past been engaged in the task of preparing and handling various materials having for their object the minimising of the moulders' anxieties in his endeavour to produce castings which should be free from rough blemishes. Eminently satisfactory results have sometimes been obtained, occasionally at the cost of a minimum of experiment and consideration, but on other occasions the result of costly experiments and the expenditure of much valuable time has had but negative results so far as the advancement of the problems were concerned.

Generally speaking, however, foundry refractories may be divided into three classes—viz., acid, basic, and neutral. The first-named is usually of service in steel foundries, and the two latter in iron foundries. Included in the former are various silicates, while in the basic section are magnesite, bauxite, and other materials of like nature, some of them far too expensive to be thought of in connection with castings for one moment. Graphite should be considered a neutral refractory, as it is neither basic nor acid.

Siliceous Refractories.

Practical men have sometimes found that acid-forming oxide, when heated and in contact with basic oxides, unites with them to form silicates, which, though in some proportions more fusible than the silica itself, yet on being mixed in other proportions raises the fusing point, and thus at once renders it of a higher commercial value for the purposes we have under notice. These exact proportions are not discovered without much patience and experiment, and even then the end of the task is not reached, for varying castings of different densities require special treatment in their manufacture. These remarks respecting silica refer principally to steel-foundry practice, but not a few ironfounders occasionally make use of acid refractories when confronted with a huge mould which has to be cast at a great heat. The practice is, however, not general, and is not very likely to be much adopted. Possibly one reason for this is the ever-varying proportions of the silicates upon which founders have to rely. The position of affairs when war broke out in 1914 was that for many years a large number of steel foundries had obtained their sand from Belgium, and at first it was thought no efficient substitute could be found. However, close research was carried out into British silica formations, and it is interesting to note that not only was the British product found to do the work as well as its foreign competitor, but that it could be produced cheaper. The steel moulder cannot concede too much attention to the all-important question of refractories, for his work is carried out at a much higher temperature than that of the ironfounder. His ever-present carefulness and close attention to the question of refractories is therefore quite understandable. His risk is great and the loss to the foundry, should a large steel casting be consigned to the scrap heap, is a very considerable item.

The Question of Sands.

It is not intended to deal in an exhaustive manner with this branch of the subject, except only as far as it relates specifically to the main subject under notice. Probably in a large number of cases the question of the refractory in its relation to the sand used is not sufficiently considered. With coal dust, at any rate in the past, it has been a case of one of the youngest boys being entrusted with the task of producing enough black sand for his mate's day's work, with all too little thought to the nature of his job. The porosity of the sand, its properties in relation to silica, oxides or alumina, were phases of the question which never troubled the lad, and the resultant day's output must necessarily have been disappointing, to say the least of it. How fallacious such a doctrine must have been is proved by the fact that to-day in quite a large number of foundries the day's mixture is in the hands of men who have made a special study of the question, and in a good many foundries to-day it is not an unusual thing to hear the physical properties of the sand discussed with considerable vigour and not a little theoretical enlightenment. The reason for this is that some technical schools have recognised the importance of the students being instructed in this department of the industry. It would be well-nigh impossible to make a different mixture for every individual job, but the importance of much more care being bestowed in this department than has hitherto been the case in a large number of foundries cannot be too strongly emphasised. However, in common fairness to the ingredients in use and to the skill of the manufacturer in the making of facings, considerable care should be exercised in the various proportions used. The mixtures should be weighed or measured, and careful note taken of particular results obtained under varying conditions. The porosity of the sand, the moisture present—always a delicate point—the grist of the coal dust, the fusibility or ultra-refractory nature of the old sand, and other points equally important, should be marked and instructions issued for variations accordingly. In a word, this branch of the art of moulding should be as thoroughly studied as the mixtures of iron which are to be put in the cupola.

Coal Dust.

The connection between the refractories and the moulding sand is easily traceable. Coal dust is used because if the sand were unsupported the molten metal would fuse the surface, and the result would be a rough, blemished casting. This fusing is caused by the alumina and oxides necessarily present in the sand as binding agents. The oxidation of the coal dust causes the presence of carbonic oxide or carbon dioxide gas, and this provides the necessary protection when the metal is in a molten condition. Not only, therefore, is it necessary that no little care should be taken in the selection of the sand used in the foundry, but it is equally essential that the supply of coal dust should be carefully watched. The porosity of the sand is a considerable factor of determination, but there are other points, notably the size of the finished casting, its purpose, whether for machining or not, etc., which should also weigh with the foundryman. In selecting coal dust for use in the foundry, care must be taken to inquire into its bituminous qualities, its ash content, its volatile matter, and, of course, its proportion of fixed carbon. No hard-and-fast rule can be laid down with regard to these variables and their proportions, for experience has taught that few men think exactly alike on this subject. It is perfectly safe to say, however, that too great a proportion of ash is most deleterious, and if used can only result in castings of a whitey-grey appearance with a particularly rough surface, and probably contaminated with sand burnt. On the other hand, if a coal of too high a carbon content be used, with a necessarily low ash percentage, the facing becomes of too refractory a nature, and the coal dust is unable to carry out the functions for which its application was intended. In this, as in many other matters pertaining to the foundry, circumstances govern in different cases, and from the practical point of view the correct mixture can only be found after various experiments.

* A Paper read before the East Midlands Branch of the Institution of British Foundrymen.

Grist.

Another matter of importance is the grist of the coal dust. If it is important to keep an eye on the porosity of the sand, surely it is equally important to watch the grist to which the men have been accustomed to use for their different tasks. It is very necessary to vary the grists according to the class of casting required from each shop, and also in consideration of the grade of sand used. This is a feature which is not always accorded the attention it deserves. For very light castings a coal dust of an exceedingly fine mesh is desirable, especially if the sand has an open tendency, while a slightly coarser yet still fine grist should be used for heavier work. The medium and coarse grades will be required for the larger classes of castings, in which it is necessary for the gases engendered to be carried away quickly, while the provision of a skin to the casting is left to a large extent to the blackings. A superfine coal dust is essential for light castings. On account of the lightness of metal the gases have not been overpowering, while the comparatively low temperature of the light body of iron has been sufficient to fuse the minute coal particles and thus give the fine surface coupled with easy stripping. Following up the early remarks with regard to the functions of coal dust, the many complaints emanating from the foundry might be eliminated if care were taken to see that the grist of the coal dust suited not only the sand but also the class of casting for which it is used. When coal dust of too coarse a grade is used, small "pits" are left on the face of the casting when cooled, and these are easily distinguishable by their formation from those indentations caused by particles of sand insufficiently milled. The application of heat from the molten metal to the small particles of coal forms a gas, as has been previously indicated. The gas in excessive quantities—excessive in consequence of the size of the particles—takes the line of least resistance, the soft molten metal, and the result is the "pits" which are too frequently seen in the finished article. Where larger castings are concerned the heavier weight of metal and the consequent increase in temperature prevents such indentations, particularly as the coatings of blacking on big moulds is generally more pronounced, and, in fact, is applied with a particular object in view.

Lime in Sand Causes Defects.

But it must not be thought that every blemish on the face of a casting or a great deal of the scabbing is due to the coal dust. As a matter of fact, there is no trade in which what may be called "luck" enters so largely. How else can certain mysterious happenings in every foundry be accounted for. Yet though some of the happenings in foundries may be classed as mysterious, it must be admitted that there is frequently a reason for many of the strange events. The author's attention was one day called by the owner of a fairly big foundry in the Birmingham district to some peculiar rusty-looking specks on his castings. Both he and his manager were positive that the imperfection was due to the coal dust, though it seemed strange that the trouble only happened in one part of the shop. Later, however, the trouble spread through all the shops, and then it seemed certain that the coal dust was to blame. Still not satisfied, further inquiries were made, and eventually it was established beyond question that the trouble was really due to the presence of lime particles in the sand. Again, it has been proved time after time that scabs on castings have been due to excessive moisture in the mould. Faulty castings, too, are sometimes caused by indifferent ramming, but possibly this may be a libel. Modern foundry practice tends all in the direction of power mixers, of which there are several good British designs on the market. In making a selection, however, considerable care must be exercised, and after all few will be found to do the work better than a hefty labourer with a shovel and the knowledge how to make use of it with effect, though the output would be greatly accelerated. As to the actual mixtures, every individual foundryman has his own personal ideas on the subject, based upon sound practical experience. Local circumstances, such as the class of castings made, sand mixing, quality of coal dust, and the exigencies of the moment, bear largely upon this point, and no one could possibly be a better judge of actual requirements on the spot.

Blackings.

Blackings or facings may be divided and subdivided into various classes, and again into various sections. The old-fashioned idea of blacking moulds, with all and sundry compounds, many of them of doubtful efficiency, some of them most evil-smelling, and not a few positively deleterious to the castings, seems to be rapidly disappearing, and in many foundries to-day the preparation of cores and moulds is carried out with the utmost care. It is outside the province of the Paper, however, to do more than refer to the various kinds of facings that have been produced to meet the demands of practical men whose experience of refractories far exceed that of a generation ago, at any rate so far as can be ascertained from existing records. Even to-day, however, there are foundrymen who hold that our forbears were little behind present-day founders in the production of castings, and really when one inspects castings turned out a century ago one cannot fail to be filled with amazement and astonishment that, with the crude methods of handling at their disposal, the old-time founders were able to produce such remarkably clever work. Within even easy recollection, however, the facing of moulds was a matter in which the rule-of-thumb methods were wont to prevail. The provision of a tub in a corner of the shop into which stale beer and other even less palatable liquids were placed, together with a few handsful of ground charcoal, will be within the recollection of most foundrymen. There seems to exist in the minds of some people the idea that anything will do as a facing or blacking for a mould. Never was there a greater fallacy. A treatise on foundry practice contains a recommendation to mix coal dust as a facing. If foundrymen want a little more trouble in their shops than they already have it is suggested that they take the advice given. Present-day methods have proved that a refractory much nearer the specific gravity of water than coal proves the best facing—in fact, one of the worst facings for high temperatures is a mixture of coal dust. The modern foundryman demands various facings suitable for the particular class of casting upon which he is engaged, care being taken to bear in mind the thickness of metal, the heat of the molten iron, and the general characteristics of the finished casting. Hence it has been established that for light castings nothing exceeds in efficiency a charcoal blacking of good quality, though expert practical men are not quite in agreement as whether a pure wood-charcoal or one slightly stiffened with a mineral admixture produces the better results. Some foundries go even further. For instance, two light-casting foundries have mixed a special facing to their own formula, and these in their turn differ to a marked degree in essential particulars. Certain it is that both these foundries enjoy a high reputation for the excellence of their castings, while the proprietor of one assured the writer that since introducing the new method he had experienced far less trouble in his fettling shop and had a considerably reduced outlay under that head. For ordinary green sand work which requires sleeking there are now prepared many mineral blackings, sometimes called "patent," which gladden the eyes of the moulder and assist to bring out a casting with that beautiful blue glossy skin so much sought after by founders. The true functions of these facings are reflected by this very anxiety of the founder. He knows that, given a good highly refractory substance, the pores on the face of the casting will be closed up, and therefore the utility of the skin does not end with the colour. He knows, too, with a blacking of the right character the cleaning off or fettling of the casting is going to be a matter of comparative simplicity, and this remark applies not only to green sand, but also to loam, dry sand, and core work. It is necessary to have a stronger,

or, as it is termed, heavier facing for the larger castings because not only has the weight to be considered, but the casting temperature in large moulds becomes a serious factor. Hence it is necessary to provide a strong refractory in which the percentage of carbon grows higher in accordance with the strain sought to be put upon it. It is on this very point that theory weakens, and where this happens, as occasionally it may, it becomes necessary to search for the real reason. On the face of the previous remarks, it might be thought that to get good results in every case it would only be necessary to raise the carbon content. But this is not all that is required. Some refractories are of so harsh a character as to preclude all thought of sleeking on a green sand mould or mixing with water or clay wash in a boss, especially when newly prepared. It is here that the skill of the blender is required, and by his agency devious facings are produced which can be held to cover all classes of moulds. In many instances it has been found that the slightest modifications of mixtures have made all the difference between a good-looking casting and a bad one. It is only seeking trouble to make use of a facing that does not possess refractory characteristics to a high degree to face a mould of considerable size which is to be cast at a high temperature. On the other hand, the presence in the blacking of too great a proportion of siliceous matter would cause infinite trouble in the way of scabbing and burning. But as previously indicated, the use of a high refractory for light castings is not usually advisable. For cores a sound refractory must be used, but the necessity of providing something that will not easily rub off after baking must be kept clearly in view. Here, again, the task of the expert has been to provide an article which will perform its work perfectly under varying circumstances, and the labour of the fettling shop has been very considerably modified in the past few years.

Graphitic Facings.

Graphitic facings may be divided into three parts, and roughly classed as plumbago, graphite, and blacklead. There are very many qualities, but it is more or less again a matter of carbon content, and those who are satisfied with the commoner kinds must not expect to obtain such good results as other founders who endeavour to procure the highest grades. Here once more the question of individual practical test comes to the front.

During the war many founders discovered to what a large extent we were dependent upon our overseas possessions for the provision of some of the grades of plumbago.

Several cargoes on the way to this country from Ceylon were intercepted by German submarines and sunk. But we have now come to an end of that particular trouble, and importations have been resumed, though not quite on the old lines. One unfortunate circumstance—unfortunate, that is, from the foundry point of view—is that as a result of war shortage the shipper discovered how useful an article he had been previously carrying at a low rate. As a direct result it is questionable whether the freightage on any other individual article of commerce rose in anything like so large a percentage as the rate on plumbago. Under these circumstances it will be obvious that a return to pre-war costs in the matter of refractory compositions involving the use of this class of goods must necessarily be somewhat slow if the old high quality is to be maintained.

DISCUSSION.

As the discussion consisted of a number of questions, the sense of it is covered by Mr. Winterton's reply, who said he was very pleased his remarks had given rise to such a number of questions. It showed the subject was one which needed serious attention. With regard to the mixture of 1-10th silica and 9-10ths plumbago it would be a costly mixture, and not likely to come into general use. He was very careful to lay it down as an essential fact that practical demonstration in nine cases out of ten was the only way out of a difficulty. But breaking away from the general rule he would say, in reply to the Chairman (Mr. Evans) that ¼ of a part of plumbago, 4 parts red sand, 1 part ganister, 3 parts of steel paint, would really be a silica paint. He thought he would find it would solve the difficulty, as he had a similar problem a little time ago.

With regard to Mr. Bunting's remarks on soapstone in plumbago, it all depended whether the plumbago one is requiring is of pure character or whether one is prepared to have a cheaper quality, and as a matter of fact get worse results and use more of it. That is really what it comes to. Insist upon the best quality; naturally the cost will be more at first, but the work will be very much more satisfactory, and one will use far less of it if the moulder can be persuaded not to waste it. With regard to small castings, these, in some cases, are a question of local practice. There are thousands of small castings cast beautifully clean with good coal-dust and a good mixture of fat. As to appearance the slightest dusting of plumbago will give the skin of the casting a better appearance. Mr. Stevenson does not apparently think that the appearance of the casting has very much to do with it. He agreed that to a practical man and to practical machine men in many cases the appearance of the casting indicates nothing, but in many cases some of these castings have to be sold, and if one can show a man something which looks very nice sometimes faults are not found out.

In answer to Mr. Grant, if he were dusting blacking on small castings he would give only a suspicion of best plumbago. With regard to Mr. Goodwin's remarks, he certainly thought it was superfluous to put a lot of blacking on a good many of the small moulds. Some small castings can be made without blacking, although a suspicion of dusting of plumbago certainly improved the appearance. With regard to the larger castings, it would be futile to attempt to pour heavy iron into an unblacked mould and expect it to come out without an enormous amount of work.

Mr. Russell spoke about a sand for use in steel. He did not pretend to recommend any particular kind of sand or any particular kind of facing. He dealt in the abstract, but he would be very pleased to give the further information privately of sands which are declared to be far better than Belgian, or at any rate its equal. He had not made much experiment with lead castings, but if Mr. Russell would make his mould a little finer and closer a good deal of the trouble would disappear.

With regard to blue glossy castings, he still adhered to his opinion that whilst the presence of that skin on the casting is, in many cases, of no actual use, but when it is desired to sell the casting it is going to be of value by pleasing the customer. He agreed with Mr. Pemberton that manufacturers of facings should give instructions. There was no question to-day facings could be obtained which meet the requirements of each individual job. He knew a firm which made 27 different brands of blacking, each one different from its fellow, and each in use for a different purpose, and that firm could tell the customer exactly how that blacking should be used to get the best results, what weight it would be safe to use, etc. That, certainly, was a step in the right direction. He felt this research would be continued, and it would be possible shortly to get a particular facing to suit any particular casting. With regard to coal-dust of too high carbon content, it necessarily followed that the volatiles would be lower, and as volatiles were required for the casting to fend off the iron, one must necessarily have a refractory if the volatiles were absent. In conclusion, Mr. Winterton said everything he had mentioned had been verified by testing and analysis.

Mr. Pemberton moved a vote of thanks for the lecture and able way the discussion was answered.

Mr. J. Lucas seconded, and the President supported.

In reply, Mr. Winterton said it was a great pleasure to come to Loughborough. He was very glad the paper had roused such discussion, for it was a healthy sign of life, not only in the foundry trade but for the Branch.

The Millom and Askam Hematite Iron Company, Limited, put another furnace into blast at their works at Millom, Cumberland, last week.

The History of Loam Moulding in the Liege District.

MR. VARLET ANSWERS HIS CRITICS.

Mr. Varlet, answering Messrs. Gallon and S. G. Smith, writes that he thanks these gentlemen for the interest they have taken in the Paper which he read at the Birmingham Conference, and desires to place on record his deep regret that he was only allowed twelve pages in which to deal with so exhaustive a subject, for he would have liked to have outlined the subject in all

Fig. 1.—Finished Core for Slag Pot.

its phases instead of being limited to four types of casting. With regard to Mr. Gallon's remarks, he would say that the workmen of the Liége district are undoubtedly very clever, especially as regards loam moulding. It is perfectly true that one man can make a 3½-ton slag pot in 18 hrs. This period is quite average when, say, three are ordered. It should be mentioned that the mould and core are made in masonry and last for three castings as set out in the paper. As regards the hole, chiselled out of the base plate for taking the strickle, a translation error has crept in. This plate is cast around the stem of the strickle, which is first doped with tar. This stem is suspended in the mould with iron wire. As soon as the metal is frozen, the arm is lifted out and given a quarter turn twisting motion, this being done before the contraction of the casting takes place.

Dealing with Mr. S. G. Smith's discussion, Mr. Varlet states that he is in agreement with him

Fig. 2.—The Core Removed Five Hours After Casting.

that loam moulding can be either cheap or expensive according to the methods adopted and the type of casting to be made. He remarked in his paper that the old loam moulders, who had little equipment, were quicker than present-day workers, and that certain castings were more quickly made in loam than in sand. Mr. Smith will perhaps be astonished when told that in 1890 the St. Léonard concern of Liége made a series of six locomotive cylinders in loam, and that the cost price was lower than when made in sand. But as stated in the paper, the contrary is often true.

Composition of Loam.

As regards the pipes made by Mr. Smith, he regretted that he could not enter into a discussion on this question, especially as to length of time taken. He found Mr. Smith's figures excellent, but he wished to state that the subject of the Paper presented was "The Origin of Loam Moulding in the Province of Liége" associated with its actual methods of working, and is not, to his mind, a comparison with those of other countries. Tannery waste, mentioned under the heading of "mixtures," is bark, either oak or chestnut, which when reduced to small lammellæ of 2 to 5 cm. long is used for the tanning

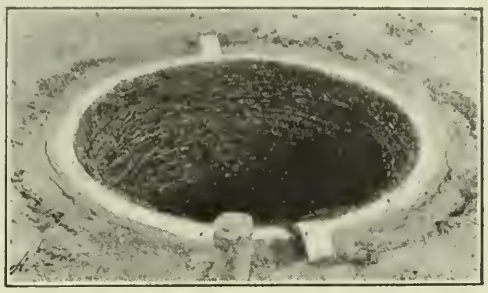


Fig. 3.—The Casting Photographed after the Withdrawal of the Core.

of hides and skins. Sand No. 1 (mortier do sable) is a mixture normally used in Belgian foundries. It includes horse litter, and not exactly dung. Horse litter has quite special properties. It is above all an excellent binder, giving high plasticity to the sand on account of the fatty and ammoniacal materials present. Further, because of the considerable straw and oat content, a high degree of porosity is given to the sand allowing of the easy escape of gas. It should be stated that it is rather expensive, and when, as it occasionally happens, it is replaced by sawdust, different results are given.

Flywheel Moulding.

He was again in complete agreement with Mr. Smith that the best method of mould flywheels is to assemble the whole in a box, and that is what is always practised in Belgium for flywheels

Fig. 4.—The Withdrawn Core Remade with Straw Rope and—on the Top—Coke. It is now Ready for Strickling.

up to 5 metres dia. But for larger wheels he insisted that the method outlined in the paper is more rapid, for no boxes are used for such large diameters. Moreover, consideration should be given to the small number of reinforcements that are used for a flywheel of 6 to 7 metres dia. compared with the method outlined by Mr. Smith in The Foundry Trade Journal of May 25, 1922.

Unfortunately, he has not one of these castings on order; it would be a pleasure for him to invite Mr. Smith to do him the honour of visit-

ing Belgium and ask him to compare the two methods of moulding outlined. Mr. Smith could then judge for himself as to whether the method of working was the most economical, the quickest and easiest, and also could examine the numerous details mentioned as to the success of the casting.

Cylinders.

Having dealt with the loam moulding of a cylinder of 2½ metres dia., 22 mm. thick, and 2½ in. high, he affirmed this was an easy casting to mould, but its complete success requires some amount of care. Mr. Smith must excuse the author if he has forgotten to say that this type of mould does not apply to repetition work, but only to an isolated casting. Up to now, he had only turned out three, and these of different diameters. They were not for an outside order.

It is probably that for repetition orders special equipment would be devised, and it is quite understandable that Mr. Smith has cast 50 cylinders without remaking the masonry. Regarding the feeding head, this is quite well explained in the sketch (see Fig. 4, No. 14) by an arrow. One alone is sufficient.

In praising the superiority of the loam moulder, he referred to those he had known in the past and those he desired to see in the future—that is to say, a man to whom one can confide a plan of a casting of the highest importance and who moulds it perfectly without having recourse to the help or the advice of anybody. He found that

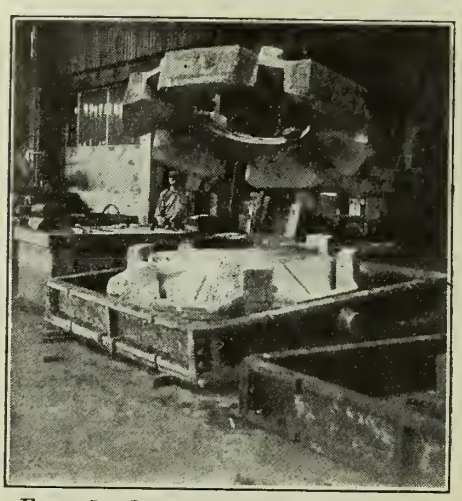


FIG. 5.—LOAM MOULD FOR A GAS PRODUCER GRATE TO BE CAST IN STEEL.

the moulder had to apply himself with all his power to imagine the construction of the mould, whilst the dry-sand moulder is usually provided with a pattern for the production of his casting. It was not possible for the writer to compare the British and Belgian moulder, for he had not the opportunity to visit a foundry during his stay in Birmingham. This is to be regretted, for he imagined that some very interesting methods of working are practised in England, and he further thought that all foundrymen ought to spread the knowledge of any methods which they find advantageous and to help foundry progress by every possible means.

When the Congress and Exhibition was held in Liége in 1921, all the visitors were invited to inspect the four most important Belgian foundries: Messrs. John Cockerill, A. Ketin, Compagnie des Conduites, and Esperance-Longdoz. The visitors expressed themselves as delighted with the opportunity afforded.

Generally speaking, Belgians are always happy to show their work, for they consider all foundrymen as friends. They looked upon the recent visit of Mr. V. C. Faulkner, the Editor of THE FOUNDRY TRADE JOURNAL, when passing through Liége, as a distinct honour, and he hoped on the occasion of the next Belgian Conference to see the members of the Institution of British Foundrymen, who, he assured in advance with all possible sincerity, would be accorded the same hearty welcome which he had received in Birmingham, and which is one of his most pleasant memories.

In sending his answer to the criticisms on his Paper, Mr. Varlet enclosed five photographs which are distributed amongst the text, being self-explanatory, except perhaps Fig. 5, which has reference to a mould for a gas-producer grate. This mould was struck up in loam, no pattern being available. It was closed up and taken a considerable distance to another part of the works to be cast in steel.

Paris 1923 International Congress.

Under the caption of "French Foundrymen Seek International Meeting," the latest number of *The Foundry* to reach England states that C. E. Hoyt, secretary of the American Foundrymen's Association, has received a formal invitation from the Association Technique de Fonderie de France to participate with the Institution of British Foundrymen and the Belgian Foundrymen's Association in a comprehensive international foundrymen's congress and exhibition to be held in Paris under the auspices of the French Association during the first two weeks in September next year (1923).

The French Foundrymen's Association has been completely reorganised since the war, and its membership now includes all of the prominent foundry industries in France. Through its efforts the Ministere de l'Enseignement Technique has loaned the buildings of the Ecole Nationale d'Arts and Metiers at 151, Boulevard de l'Hopital, where the convention and exhibition will be held. These buildings are particularly suited to this purpose. The school foundry, which is completely equipped, will be available for holding competitions and making demonstrations.

The invitations will be acted upon by the American Foundrymen's Association at the next meeting of its board of directors in September, and it is understood that arrangements will be made by the American Foundrymen's Association to insure adequate representation and attendance from the United States.

Society of German Foundrymen.

At the general meeting of the above Society, held from June 9 to 12 (the proceedings of which are reported in a recent issue of "Stahl und Eisen"), ENGINEER HUBERT HERMANN read a Paper on the use of "baby" Bessemer plants, especially of the duplex type, and on recent practical experience with German duplex plants. Among other points, he mentioned the advantages of the Zenzes small converter, the essential feature of which is that the body of the converter and the blast box are separate one from the other. The advantage of this is that the converter proper can be quickly replaced or renewed, thus saving considerable "shut-down" costs. It is now possible with this type of converter to blow metal obtained in the open-hearth furnace from steel scrap, and so work independently of the expensive hematite pig. The silicon required for supplying the proper amount of heat for the bath is obtained by adding ferro-silicon to the converter. In this way it has become possible to use the converter process in open-hearth steelworks which have no cupola furnaces, and to produce very light castings at a lower cost than hitherto, which could only be done in the electric furnace.

At the same meeting DR. E. H. SCHULZ dealt with the question of organisation in foundry and metallurgical practice generally, referring (1) to the importance of proper arrangements for testing raw materials and finished castings—points now being considered by the Institution of British Foundrymen, (2) to the necessity of closer co-operation between the mechanical testing laboratory and the works in clearing up points relating to unsatisfactory material, (3) to improved equipment for laboratories, and the necessity for separating the mechanical and chemical sections of the test laboratory, (4) to the organisation of the latter, etc. In connection with the research department, the author emphasised the necessity of a thorough system of bibliography and filing records, together with a properly indexed system of abstracts from foreign books, periodicals, and patent specifications.

The Reichert Metallurgical Microscope.

In the investigation of metals, microscopic examination is the most important adjunct to chemical analysis, for whilst the latter only furnishes information respecting the nature and amount of the constituents present, microscopic examination throws light upon the effects which a given mechanical or thermal treatment, or, the admixture of foreign substances, may have upon the structure, and therefore the physical properties of metals and alloys.

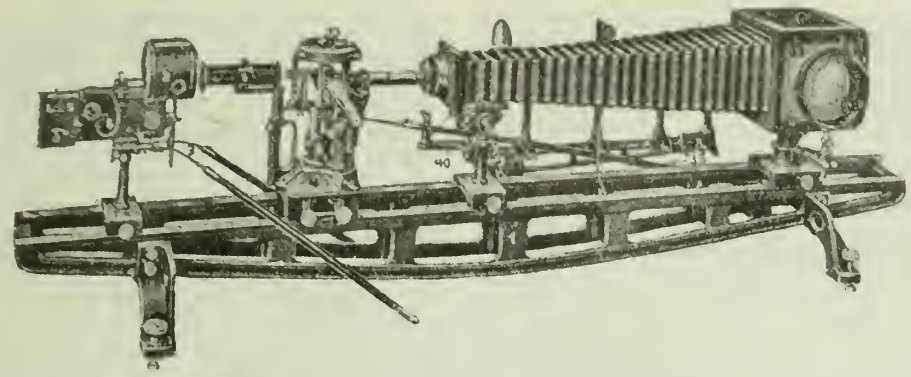


Fig. 1.—Reichert Metallurgical Bench. With Direct Vision from 30 to 1,500 Dias. are Obtained, but with the Camera the Range is from 1 to 5,000 Dias.

Metallurgical microscopes differ in construction and characteristics from ordinary microscopes in conformity with their specialised use. They find their most important application in the control of manufacturing processes concerned with the production in working of metals, and also in testing the character and value of materials, concerning which microscopic views of the structure of the materials afford exhaustive information.

A photographic camera in conjunction with the microscope enables these structural images to be recorded in a permanent form, thus furnishing valuable evidence for the use of the consignor and the consignee. For the sorting out and rejection of defective materials it is of the greatest use.

At the present time, when the costs of materials and production have risen so enormously, such a means of safeguarding and controlling manufacturing processes is of the utmost importance, and no foundry in which the quality of the materials is an important factor, can afford to dispense with the use of metallographic methods and the metallurgical microscope.

In addition it is essential in mines, steelworks, rolling mills, factories engaged in the production of machine tools, armaments, munitions, locomotives and rolling stock, automobiles, aircraft and electric lamps, shipbuilding yards, military and other national undertakings, also for railway material, etc., it is obviously necessary also in technical institutes for teaching and research.

In view of the importance of metallurgical microscopes, the Reichert concern, who are represented in this country by Messrs. O. C. Rudolph and Beesley, of 65, Margaret Street, Oxford Circus, London, W.1., have given particular attention to this branch of manufacture, and a special department has been formed at their works, which, as the result of years of experience, produces instruments specially adapted for the ends in view.

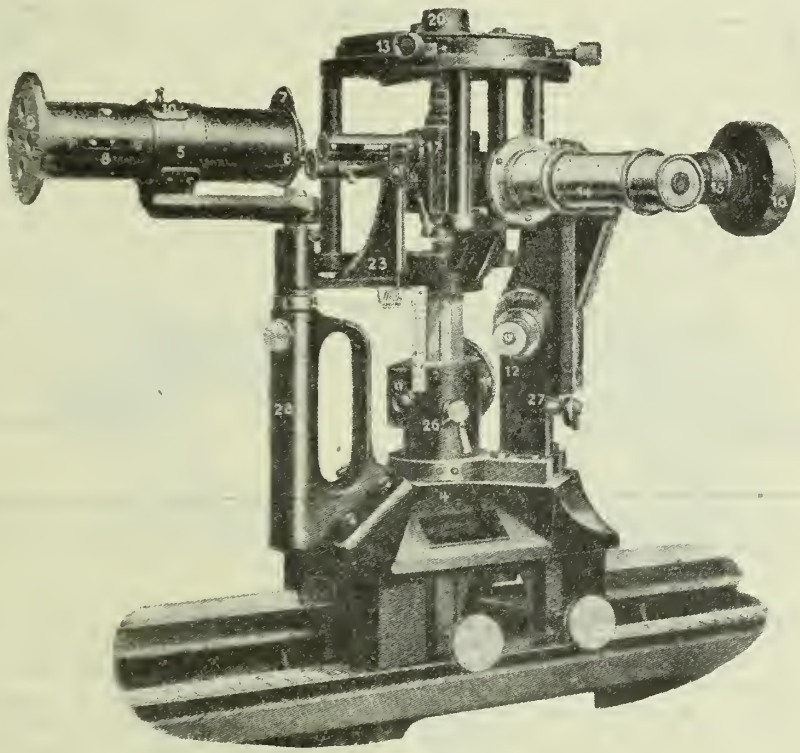


Fig. 2.—Inverted Metallographic Stand with Selective Vertical illumination by Either Prism or Plane Glass Reflector.

The "Reichert" metallurgical microscope (Fig. 1) which it is proposed to describe in this article, consists of the following principal parts:—(*a*) Large optical bench (1); (*b*) lamp (2); (*c*) microscope (4); (*d*) camera (32); (*e*) apparatus for macrophotography for the production of comprehensive images under low magnification (40).

Special Advantages.

The following points may be specially noted:—

1. The convenient arrangement of the object-stage (Fig. 1, No. 13) which on the one hand allows of observations of objects varying greatly in size and shape, and on the other hand requires only one face of the object to be ground, this face being laid in contact with the object-stage whereby it is automatically orientated at right angles to the axis of the objective.

2. The coarse and fine adjustments are independent, the object stage being connected with the coarse adjustment but not with the fine adjustment, so that relatively heavy objects can be placed on the stage without any strain upon the delicate thread of the micrometer screw.

3. The fine adjustment does not act directly but only through the intervention of an inclined plane, whereby the delicacy and stability of adjustment, particularly necessary in photographic work, are attained.

vation of the microscopic image, so that he does not need to move from the latter position to check the focussing of the photographic image.

8. Separate accommodation of the auxiliary appliances for macro-photographic apparatus is made on a small prismatic rail attached to the side of the large optical bench. These appliances are always in a position for use, on the rail, and can at any moment be brought into operation in place of the microscope.

A very stable optical bench, which covers an area of 18 by 80 in., is supported on four levelling screws, and forms the base of the whole apparatus. It should rest on a table free from vibration. To avoid vibration in steel works and the like places the whole apparatus may be suspended from the roof by wire cables.

The Microscope Proper.

The microscope, details of which are shown in Fig. 2, is constructed on the Le Chatelier principle. The massive base (4) is adapted to the pro-

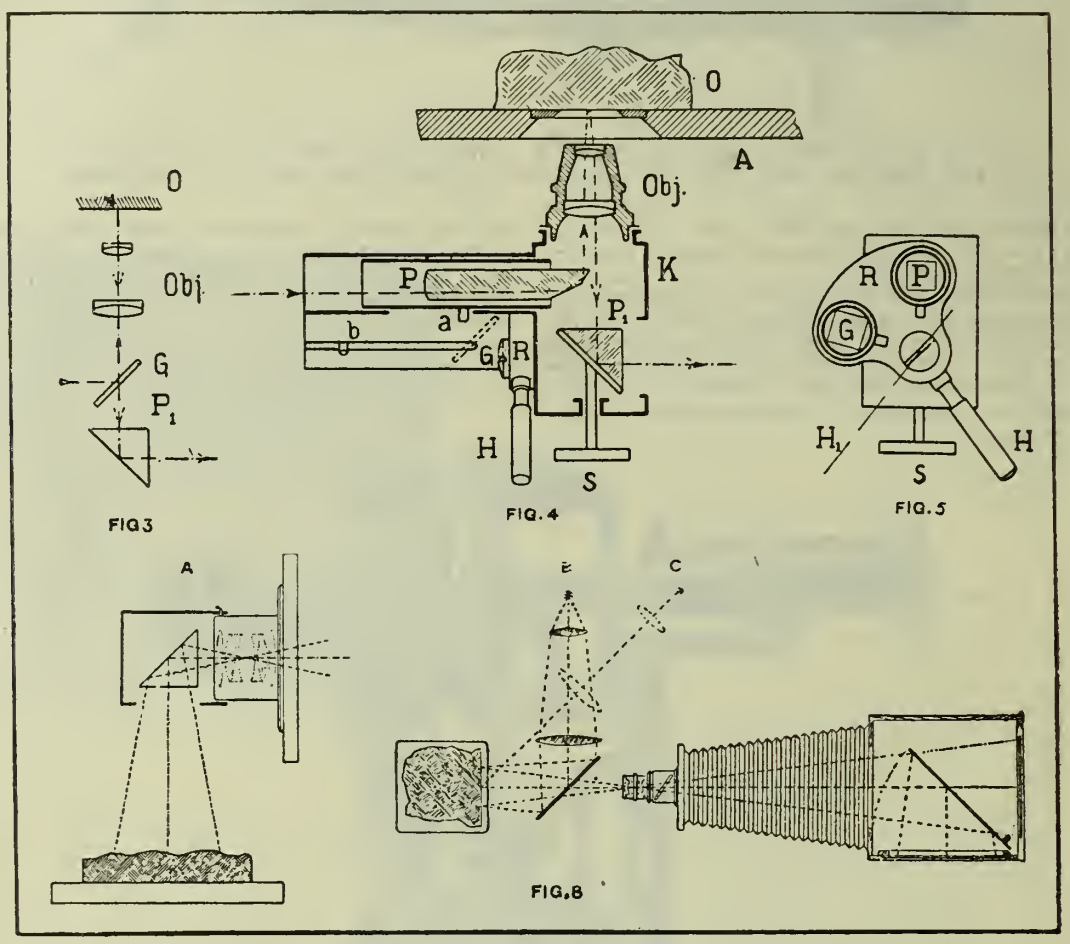


Fig. 3.—Illumination by Means of Plane Glass Reflector. Fig. 4.—By Means of Adjustable Prism. Fig. 8.—Convenient Mounting of both and Obviating any Disturbing of the Specimen.

4. A novel interchangeable illumination apparatus by means of which the object, under the lowest as well as under the highest magnifications can be illuminated by interposition of either prism (oblique illumination) or a plane glass plate inclined to 45 deg. (vertical illumination) whichever form of illumination is best suited to the object under observation.

5. An instantaneous change over from direct visual observation to photographic fixation of a microscopic image by the simple manipulation of a handle which effects the rotation of a prism 90 deg.

6. The fine adjustment of the illuminating prism is effected by a micrometer screw, in connection with which a pointer movable over a scale shows the correct adjustment for every objective. This ensures the rapid and certain attainment of the correct illumination in all cases.

7. A mirror device in the camera enables the photographic image to be observed conveniently on the ground glass plate of the camera until just before the exposure, whilst the operator remains in the same position as for the direct visual obser-

file of the optical bench, so that it can be moved with ease to any required position, and then fixed firmly by means of clamping screws. .

The objectives are fixed in position by a spring clamp, and are mounted in centrable collars by which accurate centring is assured. They can be easily and quickly interchanged by means of attached handles.

The course adjustment is effected by raising or lowering the object-stage by rack and pinion. It may be fixed by clamping screws (26) in order to prevent any change in the adjustment when heavy objects are on the stage. The scale shows the correct position of each objective, thus facilitating rapid adjustment.

The object stage is supported by four pillars, is circular and rotatable, and can also be displaced in two directions at right angles to each other by a sliding motion actuated by micrometer screws and fitted millimetre scales (reading to 0.1 mm. by means of a vernier gauge) and a registering device to enable any particular part of an object to be brought into the field whenever required.

The fine adjustment (12) of the imago is effected by means of a special vertical prism guide on which a very carefully finished micrometer screw works.

The fine adjustment (12) is the same as in the Reichert biological microscope stands, and was adapted because it has proved specially suitable for photo-micrographic work. The adjustments can be read off to within 0.002 mm. on a graduated drum.

The prism guide of the fine adjustment forms at the same time the support for the casing (17) which contains the finer optical parts of the microscope, together with the tube (14) and (15) connected therewith.

A column (28) attached to one side of the microscope base (4) is shaped so as to form a handle by which the microscope may be carried. It supports the illuminating tube (5).

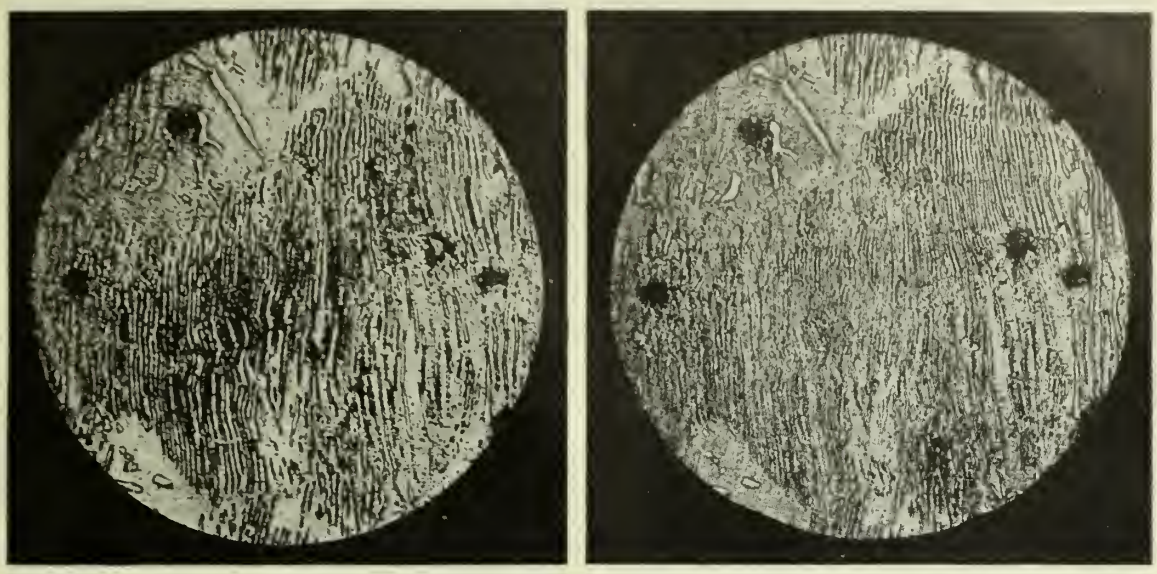


Fig. 6.—Micros of Identical Spot of a Steel Specimen by means of the Prism and Plane Glass Reflector, the Former, in this Case, Yielding Stronger Contrasts and the Latter Finer Detail.

Path of the Light Rays.

The rays from the lamp (2) (see Fig. 1) have first to pass through the illuminating tube (5) (see Fig. 2). The rotating disc stop (9) on this tube has a number of orifices of different size by which the intensity of the illumination may be varied. The light rays are rendered convergent by the illuminating lens. Slots (10) serve for the insertion of a coloured glass and for a filter cell.

After emerging from the illuminating tube the rays arrive at the interchangeable illuminating apparatus and are deflected thereby into the objective, which in this case acts also as a condenser, concentrating the light on the object to be observed. The interchanging apparatus bears two small horizontal tubes, one of which contains a prism P (Fig. 4), and the other a thin plate of glass G, with parallel sides fixed at an angle of 45 deg. (Figs. 3 and 4). By means of a handle H (Figs. 4 and 5) either the prism P or the glass plate G can be interposed at will for the illumination of the same object and without bringing the object out of focus.

According to the magnification employed and the character of the object, the prism will be found preferable in some cases and the glass plate in others. Owing to the peculiar shape of the prism, which covers one half of the objective, rays reflected at the free surface of the lenses of the objective are excluded. The images obtained when the prism is used show therefore very pronounced contrasts, and are very brilliant owing to the complete reflection of the illuminating beam by the prism. Moreover, the light is directed obliquely on the object, so that differences in the height (relief) of different parts of the object are distinctly perceptible. The position of the prism must be adjusted in a horizontal direction according to the focal length of the objective in use. This is effected by means of a micrometer screw which actuates a pointer (23, Fig. 2). The tip of this pointer moves over a scale on which the correct position of the prism for every objective is indicated. When the plane glass plate is used the whole aperture of the objective is effective. The glass plate is therefore specially suitable for the resolving of minute details of an image under high magnification (Pearlite-structure).

The iris-diaphragm (6, Fig. 2) in the illuminating tube serves to accentuate contrasts in the image when the glass plate is used.

The rays of light thrown back from the surface

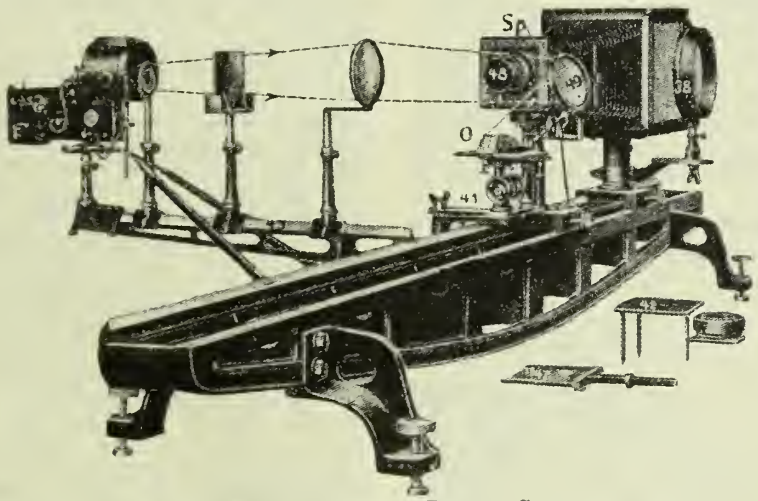


Fig. 7.—Metallographic Bench Set up for Macrographic Work. (Photographing of Large Sections under Low Magnification.)

of the object, in-so-far as they enter the objective, give rise to the image. They are deflected through 90 deg. by the image prism P_1 (Figs. 3 and 4). This prism is itself rotatable through 90 deg. by means of the knob S (Figs. 4 and 5). When the prism is in one of its limiting positions, the light rays are deflected either into the observation tube (14, Fig. 2) provided with an eyepiece in which the observer looks, or into the camera tube (15) which has a light proof connection with the camera through the tubular casing (16). In the camera tube a projection eyepiece is used, the front lens of which is screwed out more or less according to the length of the camera, so that the image of the focussing screen or photographic plate appears sharply defined when it has already been sharply focussed through the observation tube. The graduations on the projection eyepiece enable the position of the eye lens corresponding to any given camera-length to be ascertained.

The camera has a maximum extension of 80 in. It is provided with a reflex focussing arrangement (Fig. 8), when the mirror is set at 45 deg., the rays are reflected on to the focussing screen (33, Fig. 1) at the side. This enables the operator to control the image on the focussing screen from his seat at the microscope or to show it to several persons at once. A Hooke's key (35, Fig. 1) for focussing from a distance therewith in this case to actuate the micrometer screw. An observation lens (38, Fig. 1) enables the image to be conveniently examined as a whole, in order to ascertain that it is distinct and uniformly illuminated in all parts.

Objectives.

Since in metallurgical microscopes the object is not provided with a cover glass as in ordinary microscopic work, and since the length of the microscope tube in the former case differs from that in ordinary microscopes (250 mm.) owing to the different methods of illumination, objectives of medium and high powers must be specially constructed to correspond with these conditions, and objectives of ordinary microscopes therefore cannot be used.

In consequence of the one-sided use of an objective when the prism is used for illumination, in which case only one half of the aperture of the objective is utilised for the formation of the image, it appears desirable to employ the most highly corrected and perfectly constructed apochromatic objectives or at least fluorite objectives.

In making a selection it is necessary to bear in mind that a high magnification is only of value if it is accompanied by an increase in the angle of aperture of the objective, *i.e.*, an increase in the numerical aperture, for on this factor alone does the resolving power of the microscope depend.

If the numerical aperture is too small, so-called empty magnifications are obtained which do not allow of the resolution of the fine structural details.

Micro-Photography.

The Reichert metallographic bench carries at its centre a prismatic third rail, pivoted at one end so that it can be swung round 180 deg., for the purpose of supporting, in photo-macrographic work, the source of light, condensing lenses, light-filters, etc.

A small table, adjustable in height by rack and pinion movement, carries the specimen O (Fig. 7); its top plate has various levelling movements. Macrographs can thus be taken in various ways and by means of different methods of illumination.

Three different methods that can be successfully used, depending often on the weight and nature of the specimen, are shown in Fig. 8. A mirror provided in the arrangement, as shown in Fig. 7, permits sufficiently strong illumination of the specimen O to obtain a brilliant image on the ground glasses of the camera. The macro-attachments can be used for magnifications from 1 to 50, and for reductions from the size of the specimen.

Whilst the above may seem a little abstruse for foundrymen, it is a subject which is coming more and more to the front. Microscopes will be used in the future for controlling the size and distribution of graphite plates, which are synonymous with the strength and wearing properties of cast iron.

Belts for Pattern Shop Machines.

By J. Drinkwater.

The question as to whether the direct drive or the belt drive is the most satisfactory for high-speed woodworking machines is a contentious one. It is admitted, however, that some new pattern shops are installed with motors for each machine. Many experienced men are of opinion that the electric drive is too positive for woodworking machines. Be that as it may, engineers are decidedly reluctant in making changes in the patternshop involving cost. Thus, many of the machines in use in patternshops to-day do not facilitate output as they should do, because they are only fit for the scrap-heap.

It is not to be expected in shops where obsolete machines are used that much attention should be given to the belts. It is very seldom that a belt is renewed. Old belts are frequently introduced, and they keep breaking. Further, it is seldom that proper care is given to use a proper dressing. No matter of what material the belt is made, resin is fed on to it when it begins to slip. The question of correct tension is seldom considered. Belts for woodworking machines are always run at a high speed, and with high-speed belts more attention is needed, because they keep slipping at the fasteners. It is very important that the pulleys should be in proper alignment, because, if bad, it not only causes unsatisfactory working, but also shortens the life of the belts.

Some engineers do not think cotton or leather belts are suitable for high-speed drives at all, because they are subject to weather and temperature fluctuations. Certain it is that they do not retain their natural properties. One writer in a woodworking journal some time ago challenged any high-speed woodworking machine operator to test his spindle speed and his main drive speed, then to compare this with calculated speeds as found by pulley diameters, and affirmed that a discrepancy would be found varying from 20 per cent. to as high as 40 per cent., which means a very considerable loss in output.

Is rubber satisfactory for woodworking machines? Evidence seems to bear out the contention that it is. Rubber is used where the belt is exposed to the action of steam or the weather, because it does not absorb moisture or stretch, as does leather under similar conditions. In this respect it is the most satisfactory power-transmitting medium. It has also a higher co-efficient of friction between the driving and the pulley face.

For some reason or other it may be admitted that the rubber belt is seldom seen in patternshops or other woodworking shops. An important point in favour of the rubber belt is that it does not need any adjusting or shortening after it has been in use for a short time, and it does not warp.

A very reasonable, if minor, argument against belt transmission in patternshops is the inconvenience caused by running belts when long boards are being machined. The conditions are very different from those in the metal machine shops. Usually, the timber is brought in from the wood shed in sixteen-foot lengths, and if not cross cut to short lengths it is faced on the surfacing machine. It has then to be moved to the thicknessing machine, after which, in all probability, it is bandsawn to various shapes. This involves much handling, and as the machines, from space limitation reasons, are close together, considerable care has to be exercised to prevent knocking belts off pulleys. When machining timber, it is necessary for the workman to keep walking round the machine and belts, even if those on the floor level are guarded. The writer was in a patternshop recently in which no belts were to be seen, although all the machines were belt-driven. The main shaft, the counter shafts, and the belts were under the floor level. Channels were formed in the floor, over which removable flooring was fitted, and in those channels the shafting run. To change to under-floor from overhead shafting would involve considerable expense, but it is an excellent idea in laying out new patternshops. Both for lubrication purposes and for repairs, whether to shafting or belts, it is very convenient, as no belt-guards are required, and the shop is both quieter and cleaner than when the shafting is overhead.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands.

By C. W. H. Holmes, B.Met. (Birtley, Durham).

INTRODUCTION.

This investigation was undertaken with a view to estimating quantitatively the effect upon the essential properties of the sand of the various processes to which moulding sands are subjected. The essential properties that fall within the scope of this research are: (*a*) the strength of the bond; and (*b*) the ratio of the various mechanical grades, which is the determinant of the venting properties in this research.

Whilst refractoriness is undoubtedly a factor of the greatest importance, even in sands for grey-iron castings, it is obviously so slightly affected by the method of preparation, or any of the conditions here investigated, that it is not discussed in this research.

In foundries where there is no technical control, sand is treated in either of the following ways, depending upon economic conditions, with a view to maintaining a workable bond in the sand.

(*a*) In districts where a good supply of well-bonded moulding sand is available, the old sand is strengthened by means of an addition of from 10 per cent. to 50 per cent. of new moulding sand.

(*b*) In those areas where good moulding sands are expensive, owing to their distance from the foundry, it is usually the custom to replace the burnt-out bond by means of additions of 5 per cent. to 25 per cent. of "loam"; that is, a fine-grained sand having a high clay content and usually containing much silt.

Mechanical mixing is resorted to in the larger foundries in many cases; but in others, especially where "loam" is used, the mixing is done by hand.

Mechanical mixing may be effected by the following means, placed in order of general usefulness: (1) Pug mills and edge runners (pan mills); (2) disintegrators; (3) paddle mixers; and (4) mechanical riddles.

In foundries where technical control is in operation, consignments of moulding sand are usually subjected to bulk chemical analysis in which the content of iron and alumina are frequently reported together and the alkalies are estimated by difference. Such an analysis yields very little useful information as to how the sand will behave under foundry conditions.

Mechanical grading, when carried out, does not usually involve preliminary deflocculation. Thirty, sixty, and ninety mesh sieves are used; not only is this test incomplete, but the size of particle passing the various sieves depends so much upon the gauge of wire with which the sieve is made, that results are not comparable.

The thanks of the foundry industry are due to Professor Boswell in this country, and to Moldenke, Outerbridge, Lane, Hanley, Simmonds, and others in America for having introduced greater refinement into the testing of moulding sands.

Description of Apparatus.

The mechanical tests were carried out on a machine specially constructed for the purpose with a view to applying small loads, of the order of a few hundred grammes, with an entire absence of shock, and at a definite rate in grammes per sec. The machine consists of a beam 12 in. long, resting in its centre upon steel knife edges, and having similar knife edges at either end which work in hardened steel shackles. From one shackle is suspended a vessel capable of holding 2 litres of water; from the other an arrangement, as shown in Fig. 1, is suspended. This consists of two triangular pieces of mild steel, *a a*, connecting the two side pieces, *b b*, to the shackle. The side pieces support either the breaking bar *d* in the transverse test, or a flat plate in the compression test; and the tray *c*, which carries weights to balance, approximately, the weight of water on the opposite arm. The position of the transverse test-bar is shown at T (Fig. 1).

For the transverse-test, two square bars are set in a wooden frame, parallel to the breaking bar and equidistant from it, having their centres 4 in. apart; in making compression tests a flat plate is laid over these bars and the piece is crushed between this plate and another plate fixed between the side pieces in place of the transverse breaking bar. Sufficient water is run into the vessel and the test-piece is placed in position.

Water is now syphoned gently out of the vessel until the beam is floating. A measuring cylinder is then placed under the syphon, and water is allowed to run from the vessel to the cylinder by means of a spring clip until the test-piece fails; the spring-clip is immediately shut off and the volume of water in the measuring cylinder gives directly the breaking stress on the bar in grammes.

The transverse bars are rammed up in a hard-wood core-box with loose sides and loose recessed ends 6 in. × 1½ in. × 1 in., and compressed by means of a wooden top piece having a projection 6 in. × ½ in. × 1 in. to the final size 6 in. × 1 in. × 1 in. The compression pieces are made in a brass boss 1½ in. high, having a ⅝-in. round vessel to overbalance the weights on the tray *c*, hole in the centre, and are compressed by means

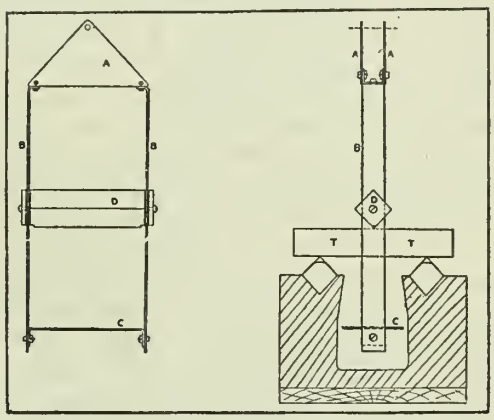


FIG. 1.—GREEN SAND-TESTING MACHINE.

of a small screw press and a ⅝-in. plunger to 1 in. high × ⅝-in. dia. They are then readily pushed from the boss.

(*b*) Mechanical grading was effected by means of a rotary shaking machine for deflocculating the sample, a Crook's elutriator, and a set of metric copper sieves with punched holes as prescribed by the Institute of Mining and Metallurgy. The elutriator is of the standard Crook type and dimensions for separating the sand grade, 1 mm. to 0.1 mm.; silt grade, 0.1 mm. to 0.01 mm.; and clay grade, less than 0.01 mm. An additional jet is used for separating the fine and coarse silt, dividing at 0.05 mm. The following refinements have been found essential in work where considerable accuracy is required.

The water, during cold weather, is passed through a glass coil in a bath of warm water, and then through a bottle containing a thermometer, so that all tests may be made using water at 15 deg. C. The sand-grade tube is clamped rigidly in an absolutely vertical position to prevent the coarse silt sliding down and being estimated as sand grade. The rubber tube connecting the constant pressure head and the sand-grade tube has, with the exception of 2 in. of rubber, been replaced by glass. This was done to avoid the errors caused by pieces of flocculent material being washed off the inside of the rubber and causing trouble in the elutriator; also, should the water pressure fail during a test, sand falls back into the rubber tube, sticks to this degraded surface, and is lost so far as the test is concerned.

For the bond adsorption test a rotary shaking

machine has been made. It consists of a wooden disc, 1 in. thick and 1 ft. 3 in. dia. mounted on a central spindle, and worked by a friction drive direct from the shaft of a ½-h.p. motor. The rotating speed is 50 rev. per min., and the machine is so arranged that one, two, or three bottles may be rotated at once without unbalancing the disc.

The 6-ft. mill used for milling the sand is an edge runner of the usual type and runs at 25 revs. per min. One of the rolls, which weigh 6 cwts., is plain and the other toothed; two distributor plates are fitted to bring the sand under the rollers. The disintegrator is of the horizontal type, the disc 24 in. dia., and the speed 750 revs. per min.

Methods Employed.

After many experiments in ramming up test-bars of sand the most consistent results were obtained by tempering the sand to a moisture content of 7.5 per cent. and ramming up a definite weight of sand by means of the following standardised series of operations.

For the transverse test, 180 grs. of sand were taken; the sand was filled lightly into the assembled core-box until level with the top and pressed down by ten light strokes with a spatula handle. The remainder of the sand was filled in and the process repeated. The top was then placed in position, pressed down by hand, and driven home by ten strokes of a hand hammer.

The compression pieces were made by compressing 8 grs. of sand to the required volume in the mould by means of a screw press.

Stronger bars than those used in these tests can be made by increasing the weight of sand per unit volume of the test-bars; they have not, however, given such reliable results as have the bars prepared in the above manner. The use of a small pneumatic squeezer is under consideration as a refinement of the above method.

The samples were prepared for elutriation by taking 10 grs. of the sample, previously dried at 110 deg. C., and passing it through a 1-mm. sieve. Any residue remaining on the 1-mm. sieve was examined and any grain aggregates were crushed between the fingers and returned to the sieve; any final residue on this sieve was weighed.

The sample sieved to 1-mm. was transferred to a 500 c.c. stoppered bottle, 250 c.c. of water, and 5 c.c. 10 per cent. ammonia added, and shaken for an hour on the rotary shaking machine in order to deflocculate the clay. Eight to ten litres of water were usually found to be sufficient to remove the clay grade from the elutriator, which was collected in litre-graduated cylinders (this afforded a running check on the rate of elutriation, which was kept steady at 100 c.c. in ninety seconds), and allowed to settle out in Winchester bottles. Five minutes before the end of the test, the clip between the sand and the silt vessels was partially closed to avoid the coarse silt running back into the sand vessel. In the case of a sand such as Mansfield, where a large percentage of the grains vary between 0.15 mm. and 0.08 mm., this precaution is very necessary.

The silt grade was elutriated into two grades, 0.10 mm. to 0.05 mm. and 0.05 mm. to 0.01 mm. after removal of the sand grade from the lower vessel, by means of a different head and jet; working at 27.5 c.c. per 100 secs. The bulk of the water was decanted from all grades, which was subsequently dried at 110 deg. C. and weighed. The sand grade was then divided on the sieves and the fractions weighed.

The bond adsorption test was carried out after the method of Hanley and Simmonds. From 10 to 20 grs. of sand, depending on the bond, were weighed into a 500-c.c. stoppered bottle and rotated for an hour with 250 c.c. of distilled water and 5 c.c. of 10 per cent. ammonia. A solution of acetic acid, of such strength that 5 c.c. rather more than neutralised the ammonia, were added, and sufficient crystal violet dye (to give at least 0.004 grs. excess after adsorption) dissolved in 100 c.c. of distilled water. Any dye remaining in the beaker was rinsed into the bottle with 40 c.c. of water (making a total volume of 400 c.c.) and the bottle shaken for a further two hours. After standing for some hours, 100 c.c. of the clear gradually raised to 60 deg. C. After the whole of acid and 25 c.c. of water added, and the excess of dye was removed by introducing a 5-gr. hank of mordanted cotton yarn, the temperature being gradually raised to 60 deg. C. After the whole of the dye had been removed from the solution, the yarn was withdrawn, washed, and dried at 75 deg. C. This hank was then compared with a series of similar ones, on each of which a standard weight of dye had been deposited. From this the weight of dye adsorbed by the bond of the sand is calculated.

The analyses were made on 0.5 gr. of the finely ground sample. Loss on ignition was determined, and a fusion effected by heating the residue with 5 grs. of fusion mixture.

Silica was separated by two extractions; the yield of silica obtained on taking the filtrate from the first residue to dryness being usually of the order of 0.6 per cent.

Iron, alumina, titanium, and phosphorus were separated by precipitation on ashless-pulp fibres with ammonia. From the weighed residue, iron was estimated by stannous chloride and di-chromate and the alumina as phosphate. Lime was precipitated as oxalate and estimated volumetrically with permanganate. Magnesia was weighed as the pyro-phosphate. The alkalies were determined by the Lawrence-Smith method and separated by perchloric acid.

The casting tests were made in the following manner: Three circular moulding boxes, each 4 in. deep and 1 ft. 6 in. dia., were taken. One of them was rammed up with floor sand and dried; over this was placed a disc of 30-mesh iron gauze 18 in. dia., having a 3½-in. hole in the centre.

A second box was placed upon the gauze and rammed up with the sand under investigation round a cylindrical pattern 8 ft. long, 3 in. dia., placed in the centre of the box. A good joint having been made, straight wires of tin, lead, zinc, aluminium, and silver, each exactly 6 in long, were laid radially along the joint and touching the pattern, filling an angle of 60 deg. The third box was now put on, rammed up, the position of the wires marked on the box, and the metal was poured into the green-sand mould. The object of the dry-sand drag and the wire gauze covering was to provide a solid foundation for the mould without risk of contamination of the sand whilst on the foundry floor or whilst taking the samples of sand from the mould after casting.

The samples of sand were taken, after the mould had cooled down, as follows: The sand up to ½ in. from the face of the casting was isolated by pressing down through the sand a cylinder of tinned sheet. About 90 deg. of the cylinder was cut away and ½ in. of edge turned in at each side, so as not to cut the wires. The samples at 1, 2, and 4 in. from the face of the mould were taken by means of a tinned sheet tube 1 in. dia.

When all tube samples were taken and transferred to their respective tins the casting and sheet metal casing were removed, the sand transferred to its container, the wires carefully dug out, and the length over which they had melted was measured.

(To be continued.)

Malleable Iron Melting by Powdered Coal.

When powdered coal was first applied to malleable furnaces, considerable difficulty was experienced in bringing the bath to the desired temperature without large oxidation losses. To overcome this difficulty the Grindle Fuel Equipment Company, of Harvey, Ill., U.S.A., have designed a furnace having burners entering directly into the chamber which contains the hearth and in such a manner as to cause the flame to create a circulating motion to the bath, so that all parts of the bath will be quickly brought to a high temperature. This construction was first put into operation in 1919, and has since then been employed with much success by some of the largest malleable foundries in the United States. The system is covered by Letters Patent.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

Discussion on Mr. F. Darley's Paper on the Production of Steel Castings.

The Branch-President (Mr. Paterson), in opening the discussion, said that steel founding was not a particularly common practice in this neighbourhood, and when we see the various designs for casting the intricate and dangerous castings which Messrs. Thos. Firth & Sons have successfully turned out, one cannot be surprised at the high name they have attained.

Mr. Wallis said that if we had reached the stage in which castings could be made of stainless steel many troubles would disappear. In the moulds shown by Mr. Darley he saw no signs of chills used to get uniform cooling, and he would like to know if one could use that practice in steel castings.

Mr. Darley, in reply, said he quite believed that in a short time we would be able to make stainless steel castings, and that he knew for a fact several firms had made propellers in stainless steel. With regard to chills they used to use them, but not now. If a chill was put against a steel casting, unless there were chills all round, it would be liable to cause pulls and cracks on the face where the chill joins the sand.

Mr. Frier asked what sort of chaplets were used for steel castings in green sand, and if so whether they would give the same trouble as in the iron foundry. Further, he would like to know what was the maximum weight of steel that could be cast green.

Mr. Darley replied that if it was a light job ordinary tinned chaplets were used; for heavy work turned steel barrel shape, he considered, were the best, but in stainless castings they must be of stainless steel.

Composition and Fluidity.

Mr. Smalley asked if the rise of fluidity was an effect of temperature rather than one of composition, as suggested by Mr. Darley.

Mr. Darley said that they had had a lot of trouble, which they traced to the analysis. When this was examined they were told that there was nothing wrong with the steel. He (the speaker) thought that it was on account of the steel not being sufficiently fluid, but he was ridiculed, and told that the steel could not be too pure. He had increased the silicon to 0.4 per cent., the carbon to 0.22 per cent., the manganese to 0.7 per cent., and the phosphorus to not exceeding 0.06 per cent., but where the phosphorus, sulphur and silicon were low the castings were full of blow- or gas-holes on the bottom side as cast.

Mr. H. J. Young agreed with Mr. Darley on the question of impurity and fluidity. He felt that many people were too inclined to term everything as an impurity, and believed steel could be too pure the same as cast iron is sometimes made too pure by taking out the things that make it cast iron. He thought it possible that by having material too pure it would give a bad casting. He had seen many faulty castings in steel, and hoped some of the local steel founders would not be frightened to come to those meetings and talk over their troubles. He thought that Germany made better castings than us, simply because they tried harder. If only steel founders would attend meetings, read papers, and discuss difficulties British steel castings would improve as a result.

Manganese Steel.

Mr. Flack asked why it was that some manganese steel wheels from 30 lbs. to 50 lbs., containing 30 per cent. manganese, broke into pieces after annealing and plunging into cold water.

Mr. Darley said he thought that people who ordered manganese steel castings for wheels were seeking trouble. In intricate castings, such as wheels, he was not surprised at some breaking, it all depended upon the analysis of the steel being correct, which should be about 15 per cent. manganese.

Mr. Brown asked with regard to the ingot moulds cast with headers whether the same thing is done with large steel castings. Working in cast iron one gets contraction difficulties. He also asked if the section of ingot shown on the screen was that of a normal one.

Mr. Darley replied that he had explained that it was an extraordinary one, and that the majority were not piped above 6 in. Similar headers might be possible in steel castings, but he saw no advantage for cast-iron castings as the header box served the purpose.

Mr. Paulin said he admired the castings illustrated, but possibly the usual flaws were lost by reproduction. He was interested in the ingot casting, and presumed that in order to reduce the piping effect it was preheated. He remarked that in some of the loco. wheel centres the boss looked extraordinarily heavy compared with the arms, and asked if they could have used a collapsible cast-iron core in order to hurry up the cooling. He wished to know whether stainless steel was ever used for chaplets. Could ingots be cast in sand moulds?

Locomotive Wheel Centres.

Mr. Darley said that casting ingots in sand moulds was not a paying proposition. If one watched a row of ingots after casting one could follow the process of the contraction, and immediately the metal is cast it begins to sink. The ingots made nowadays have not more than 5 in. or 6 in. pipe. He remembered about 30 years ago how firms making loco. wheel centres used to have to knock the mould to pieces as soon as they were cast to get the castings out to relieve contraction, but this was overcome by using different material for the boss.

Annealing Steel Castings.

Mr. Carmichael asked whether the annealing stove could not be dispensed with. He said he knew of some satisfactory castings made in Germany about 12 years ago which were not annealed. He wanted to know if it was possible to have castings of stainless steel made without the use of the annealing stove, or if it was just as important with stainless steel to incur the extra cost and time of annealing.

Mr. Darley answered that it was possible to a certain extent, but the casting structure had to be broken down. They could get the same test within a ton, and a very small percentage of elongation. He quite believed that some people did not anneal light steel castings, it was not really necessary, but his firm annealed everything they turned out.

Mr. Gresty asked whether the casting temperature was controlled, or did they have to take the metal as the furnace gave it to them.

Mr. Darley replied that 1,600 to 1,700 deg. was the proper casting temperature for mild steel. The milder the steel the hotter it should be, and the hotter the steel the greater the contraction. He had an experience of a large spur wheel cast in two halves, both cast in the same heat, and when measured one would be found to be $\frac{1}{2}$ in. smaller than the other, and it is worthy of note that invariably the casting cast first is the smaller, because the higher the temperature the greater the contraction.

Mr. Mathews asked the thickness of the steel blades in the turbine casting exhibited.

Mr. Darley replied that the thickness of the blades was 3-16 in. He said that they had made some experiments with the blades made in stainless steel, and that they stood it better than mild steel.

DISCUSSION AT SHEFFIELD.

The Chairman, Mr. John Watson, said they had listened with great interest to Mr. Darley's Paper, which had been distinctly descriptive, and, he might say, that there were very few points brought out that would make them have an acrimonious discussion. A brief general discussion followed, during which Mr. Hyde said that one of the most interesting things he saw in Belgium was a moulder working practically without a pattern, but he was given a blue print. It was a tremendous eye-opener to him (Mr. Hyde). He was pleased to see that they were getting halfway to it even in that conservative city of Sheffield.

He would like to know whether the lecturer found that contractions were likely to vary. Sometimes they found that contractions on the Monday were different to what they were on the previous Thursday.

Mr. Bradley congratulated Mr. Darley upon his Paper, and said the interesting part to him was the number of moulds they made in the floor in preference to boxes. He asked how Mr. Darley brought into circle the spur-wheel rim that was $\frac{7}{8}$ in. out. Could he give them any idea of the weight of head they put on the various sized castings?

The Chairman said that the Belgians, in order to help contraction, sank holes about 3 ft. deep, 3 in. at the side of the mould, right round the castings, and almost before the metal was set they filled these holes with water. It was a method of helping contraction he had never seen practised in Sheffield.

Mr. Darley, replying to Mr. Watson, said contraction was generally on the inside. Then with regard to the wheel, it was $\frac{7}{8}$ in. only. It was a difficult problem to get an oval thing round. He got a 150-ton jack, put it inside across the narrow diameter, and forced it out until they got it true. He put a strong stay on each side of the jack, took the jack out, put the casting into the furnace, and heated it up to about 650 deg. C. and it came out sound. With regard to feeding heads most of the big castings generally ran out about one-third. Contraction was a very uncertain quantity, and depended mainly upon the analysis and temperature of the steel. There was nothing impossible in connection with steel castings if they knew how to handle them.

The Chairman said they had been much pleased and instructed by Mr. Darley's lecture, and he had pleasure in proposing a vote of thanks should be accorded to him. This Mr. Hyde seconded.

Aluminium Alloy Pistons.

By F. A. Livermore.

Since the introduction of aluminium alloy pistons, some nine years ago, the two chief difficulties has been the development of a suitable alloy and a satisfactory design. The use of aluminium pistons has been the subject of diverse controversy, and in considering their adoption the following difficulties arise :—(1) The strength of the material must be such that it will resist shocks as occur in internal combustion engines, especially momentary increments of pressure arising from pre-ignition. (2) The material must have a high thermal conductivity since the heat is intermittently applied only to the head of the piston. (3) The coefficient of thermal expansion must be comparable with iron, otherwise the increase in clearance to compensate for a greater coefficient of expansion would cause piston slap until the engine warmed up. (4) The alloy must be capable of resisting the wear of the piston rings and (5) the alloy must be readily compounded and worked.

Some tests made by Dr. A. H. Gibson, suggested that the temperature to which pistons are exposed in service is in the neighbourhood of 250 deg. C., although from pure metallurgical evidence of the writer, prepared specimens of piston alloys have shown a marked change in internal structure, which must have occurred at temperatures well above 250 deg. C. On the other hand it is advocated by some metallurgists that in high-efficiency internal combustion engines the head of the piston attains a temperature close to the aluminium-copper eutectic (well over 500 deg. C.) and piston failure is only avoided by efficient lubrication. It seems most probable from the results obtained from the use of aluminium pistons that the attainment of these temperatures must be exceptional, and the temperature to which pistons are exposed during the working stroke is in the neighbourhood of 250 deg. C.

However, the thermal conditions under which the casting is required to work, is very different to the working at ordinary temperatures. Most alloys of aluminium decrease in tensile strength proportionately with rise in temperature. Consequently, in considering the adoption of a particular alloy, the ultimate strength at temperatures between 200 deg. and 400 deg. C., subject to such alternating stresses as would occur in the cylinder, must be ascertained. A fair amount of experimenting has been done in this direction, and some useful data established.

The zinc series of alloys show rapid deterioration with rise in temperature, and are unsuccessful.

The plain copper-aluminium alloy of 7 to 12 per cent. of copper have answered fairly well in practice, but around the temperature of 250 deg. C. in varying degrees, the alloys show a falling away of tensile strength with rise of temperature and a marked decline in the thermal conductivity, which is a disadvantage, since with a high thermal conductivity piston, a greater compression ratio can be used without fear of pre-ignition.

The addition of manganese up to 1 per cent., to the copper series of aluminium alloys, maintains the tensile strength at a high temperature, but unfortunately lowers the thermal conductivity, and the piston works at a higher heat, which is not desirable.

The National Physical Laboratory advocates the suitability for pistons of an aluminium alloy containing 4 per cent. of copper, 2 per cent. of nickel, 1.5 per cent. of manganese, which in the form of 1-in. dia. chill-cast bars, gave an ultimate stress at 250 deg. C. of approximately 12 tons per sq. in., compared with 7 tons for a 12 per cent. copper alloy. This alloy was largely employed for piston work a few years back.

Comparing the thermal conductivity of an aluminium alloy piston with cast iron, it is in the ratio of approximately 4 to 1, or, the power of heat conducting of the alloy is four times as great as the cast iron. This allows for increased compression, considerably minimises pre-ignition, decreases carbonisation and leads to a considerable fuel economy. Dr. A. H. Gibson in a series of experiments found that the aluminium piston yielded 6 per cent. greater horse-power with 5 per cent. less fuel, an increase in thermodynamic efficiency of 12 per cent., and the reduction of inertia forces to such an extent that vibration is practically eliminated and much high speed can be attained.

However, some cases of burnt aluminium pistons have come to light, and show the upper side of the piston-head to be pitted similar to a sand-eaten casting. No doubt the cause from the engineering standpoint has been the failure of the lubrication system, or through a badly designed piston. From the metallurgical standpoint, the failure appears to be due to the fusion and migration of the copper-aluminium eutectic, with the ultimate disintegration of the whole metal. It is necessary when casting piston alloys, to keep the temperature as low as possible to avoid the existence of large connected masses of copper-aluminium eutectic. A well-designed piston should have a considerable body of metal in the head (up to $\frac{1}{4}$ in.) and behind the piston rings, so as to ensure adequate cooling, but on the other hand, the increase in clearance, rendered necessary by the greater coefficient of expansion is apt to cause a certain amount of noise and looseness (piston slap). It has been found, experimentally, that the clearance should be 50 per cent. greater than with a cast-iron piston. No appreciable wear, either to the body of the piston or in the ring grooves, takes place; the supposed so-called "growth" of aluminium alloy piston has had careful experiments, and has been found to be practically negligible in comparison with the thermal expansion. From experiments by the National Physical Laboratory, the permanent growth amounts only to 0.0004 in., which can be completely eliminated by previous annealing, and so it seems that growth is not a factor for serious consideration.

The question of heat-treatment of the alloy pistons is very necessary to obtain the best results. The cast pistons are subjected to a temperature of about 380 deg. C. for at least 6 hours, though it is preferable to prolong this annealing to one day, in order to bring the copper-aliminium compound (CuAl) into solid solution. This heat-treatment gives homogeneity to the structure and also neutralises casting strains; it greatly improves the mechanical properties of the alloy, particularly when working at the higher temperatures.

Trade Talk.

The Govanhill Ironworks, Glasgow, are about to resume work after having been closed down for a period.

Bertrams, Limited, St. Katherine's Works, Sciennes, Edinburgh, propose to carry out extensions at their Westfield Foundry.

Whitehouse Bros., Limited, Bridgetown, Cannock, have taken over the business of William Gilpin, Senr., & Company, Limited, axle and edge tool manufacturers, of Cannock.

New classes in elementary metallurgy for foundrymen have been approved by the Higher Education Committee of the Crewe Town Council during the coming winter session.

Ledward & Beckett, Limited, condenser and pump manufacturers, have removed from King's House, King Street, London, E.C.2, to Parliament Mansions, Victoria Street, Westminster.

Bowes Scott & Western, Limited, mining machinery manufacturers, have removed from King's House, King Street, London, E.C.2, to Parliament Mansions, Victoria Street, Westminster.

Meldrums, Limited, Timperley, near Manchester, received sixteen orders for their forced draught furnaces last month, including 1 pumping station and 4 collieries (repeat). Orders for 3 destructors were also secured.

A circular to the shareholders of Bolckow, Vaughan & Company, Limited, of Middlesbrough, states that the directors have decided to postpone the ordinary general meeting of the company to a date later in the year than is customary.

Ironclad Switchgear Company, Limited, have removed their London office to 23, Queen Anne's Gate, Westminster, London, S.W.1, which will deal with inquiries emanating from South Wales, Midlands, East Coast, Southern Counties and Overseas.

In the vestibule of the offices of Babcock & Wilcox, Limited, Moorpark, Renfrew, a memorial has been unveiled to the memory of the employés who fell in the war. The ceremony was performed by Sir John Dewrance, chairman of the company, whose gift the memorial was.

Mr. Philip Chapman, under the style of Philip Chapman & Company, at 5, Copthall Buildings, Copthall Avenue, London, E.C.2, has re-established himself in business as an iron and steel export merchant, a business which, prior to the war, he carried on at 36, Victoria Street, London, S.W.

Claiming to be the oldest man in the country to have followed up the duties of a moulder for a period of 71 years, P. Worton, a native of Sedgley, near Dudley, is still in the employ of the Cannon Ironfoundries, Limited, Deepfields, near Bilston, whose service he entered when only nine years of age. He is now 80 years of age, and is still following his employment as a moulder.

The Whitehaven Hematite Iron and Steel Company, Limited, have restarted one of their furnaces at Cleator Moor. These works were stopped about two months ago. The iron-ore mines belonging to the same company are also being restarted at once. These will include the Town Head Mines, Egremont, Parkside Mines, Frizington, and Fletcher's High House Mines, Frizington.

J. G. Kincaid & Co., Greenock, who hold a sub-licence from Harland & Wolff for the construction of Diesel engines on the Burmeister & Wain system, have received an order for a set of six-cylinder engines of this type. The engines are to be capable of developing 1,350 b.h.p. Another similar set, capable of developing 1,900 b.h.p., has been ordered by a Spanish firm for early delivery.

The ascertainment for August under the sliding scale in operation in Cumberland and North Lancashire shows that during the month the price of West Coast ordinary hematite pig-iron fell from 98s. 8d. to 91s. 3d. per ton. Blast furnacemen's wages accordingly drop 26½ per cent. above the standard, but an agreement between the ironmasters and men stipulates that they shall not descend below the minimum of 35½ per cent. above the standard.

The National Gas Engine Company, Limited, Ashton-under-Lyne, point out that they will be pleased to render assistance during the coming winter to lecturers wishing to deal with the subject of internal combustion engine and suction gas plants. They have a selection of lantern slides, views of works, installations, sectional views, etc., which are for loan free of charge. Assistance in the preparation of lectures as far as their own manufactures are concerned is also given.

A series of meetings of the men engaged in the steel melting and rolling trades was recently held on Tees-side to consider the proposal of the employers that the war-time arrangement of the three shift system should give place to the old working system of two shifts of twelve hours each. Another change already brought about is that of one first-hand having charge of two furnaces instead of the usual working of a "first hand" at each furnace. The grading of the other men employed on a furnace is also under review. The meetings that have been held, however, have been in the nature of joint conferences of all the men affected by the proposal which had been referred to the men by the officials of their association. The decision of the meetings held was not to accede to the proposal.

Mr. W. E. Highfield, president of the National Association of Supervising Electricians, speaking in London, said the electric industry, in common with all other industries, was in a position of great difficulty. If they were to regain their lost position in the world's markets it could only be done by regaining their reputation for making high-class apparatus and being satisfied with a reasonable profit. The nation now appeared to be setting seriously to work. For the year 1921 the majority of engineering firms probably did not reach more than one quarter of the output necessary to pay a return on capital. For the year 1922 that output had probably increased to one-third or one-half. Were they to go through 1923 without any further trade disturbances, their industry should reach an output that would pay a return. If a sense of security prevailed the flow of work would increase, and the recovery and ultimate prosperity of the industry would be assured.

British Electric Furnace Prospects.

A distinct movement is on foot for the greater application of the electric furnace to the non-ferrous industry, where, although of more recent application, it is already relatively much more important in the world's production than electric steel furnaces. Should the price of current be seriously lowered in the near future, a large field would open for the extension of electric heating for heat treatment, mould and core drying. Of all metallurgical considerations, none can show greater advantages than is bestowed by a well-controlled heat-treating furnace. Its possibilities are great, as its temperature variations are confined within small limits.

Iron and Steel Output in August.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in August amounted to 411,700 tons, or 12,600 tons more than in July. The average monthly output in 1913 was 855,000 tons. The August output included 120,200 tons of hematite, 137,400 tons of basic, 102,200 tons of foundry, and 22,900 tons of forge.

The production of steel ingots and castings amounted to 520,800 tons, or 47,700 tons more than in July, but still only 69 per cent. of the average monthly production in 1920, and some 118,000 tons below the average monthly output in 1913.

Chemical Research.—Summarising his conclusions at the close of his address on "The Organisation of Research" before Section B. (Chemistry) of the British Association at Hull, Principal J. C. Irvine, D.Sc., F.R.S., remarked that the first and most important condition is that in each institution there should be a Board or Standing Committee entrusted with the supervision of research. The functions of such a body would be widely varied, and would include:—(1) The allocation of money voted specifically from university or college funds for research expenses. (2) The power to recommend additions to the teaching staff in departments actively engaged in research. (3) The recommendation of promotions on the basis of research achievement. (4) The supervision of regulations governing higher degrees. Among the more specific problems which confront this Board are the following:—(1) The creation of research libraries where reference works can be consulted immediately. (2) The provision of publication grants, so that where no periodical literature is available the work will not remain buried or obscure. (3) The allocation of travelling grants to enable workers to visit libraries, to inspect manufacturing processes, and to attend meetings of the scientific societies. The author was convinced that it was a mistake for a governing body to call for an annual list of publications from research laboratories. Nothing could be more injurious to the true atmosphere of research than the feeling of pressure that papers must be published or the Department would be discredited.

Company News.

Presswell Engineering & Welder Company, Limited, Bradford.—Capital £2,000. Directors: W. C. Priestley and H. D. Blackhurst.

Cunliffe Brothers, Limited, 33, Castle Gate, Nottingham.—Capital £1,000. Engineers, founders, etc. Director: J. W. Cunliffe.

C.R.L., Limited, 604, Fulham Road, London, S.W.—Capital £3,150 in 3,000 " A " ordinary of £1 and 3,000 " B " ordinary shares of 1s. Engineers.

Birchfield Foundry Company, Limited, Chain Walk, Birchfield, Birmingham.—Capital £3,000 in £1 shares (1,000 ordinary and 2,000 preference). Iron, steel, brass and metal founders.

W. H. Baker, Limited, Clayton Street Brass Foundry, Clayton Street, Wigan.—Capital £20,000 in £1 shares (10,000 6 per cent. cumulative preference and 10,000 ordinary). Brass founders.

British Aluminium Company, Limited.—Ordinary dividend, 5 per cent. per annum, less tax, for six months ended June 30; preference dividend, 6 per cent. per annum, less tax, for same period.

Badman Brothers, Limited, Beaufort Street, Cricklewell, Brecon.—Capital £10,000 in £1 shares. Engineers. Directors: C. H. Badman, W. F. Badman, J. A. Badman, E. G. Badman, and H. G. Inray.

Singleton & Priestman, Limited.—Capital £5,000. Edge tool manufacturers and merchants, etc. Directors: E. Priestman (permanent director and chairman), W. T. Montford, G. W. Womersley, and Barbara Priestman.

William Beardmore & Company, Limited.—Profits, £127,287; brought forward, £711,909; total, £839,197; interim dividend on preference, £43,200; balance, £795,997; final preference dividend, £43,200; carried forward, £752,797.

Nobel Industries, Limited.—Profit, £809,242; disposable balance, £604,264; brought forward, £757,498; preference dividend paid; ordinary dividend for year, 5 per cent., less tax; investment reserve account, £350,000; carried forward, £463,349.

Parc Engineering Company, Limited, 142, Earlsdon Avenue, North Coventry.—Capital £2,000 in £1 shares, to take over the business of machine tool manufacturers and engineers carried on by Parc, Limited, at Clarence Works, Lockhurst Lane, Coventry, and to adopt an agreement with M. G. Dadley.

Gazette.

Reid Bros., Engineers, Limited, are being wound up voluntarily, with Mr. H. Ashford, 91/3, Bishopsgate, London, E.C.2, as liquidator.

The Hendon Metal Works, Limited, 176, The Broadway, Hendon, Middlesex, are paying a first and final dividend of 6s. 6¾d. in the £.

Electrical Industries, Limited, 9-10, Pancras Lane, Queen Street, London, E.C., are paying a first and final dividend of 5 1-7d. in the £.

The partnership heretofore subsisting between Messrs. P. A. W. Parkyn and G. I. Murray, Junr., Vulcanite Engineering Works, Carrington Field, Stockport, under the style of Murray, Parkyn & Company, has been dissolved.

Messrs. E. G. R. Parr, W. E. R. Parr, E. H. Parr, A. C. Parr, H. K. R. Sutton, engineering, electrical and general pattern and model makers, etc., 224, Bermondsey Street, London, S.E.1, trading under the style of E. B. Parr & Company, have dissolved partnership.. The business will be carried on in future by Messrs. E. G. R. Parr and W. E. R. Parr.

Personal.

Mr. T. Eaglesfield, district locomotive superintendent for the Midland Railway Company at Hasland, will retire after 51 years' service on the 19th inst.

The late Mr. W. H. Brittain, J.P., of Storth Oaks, Sheffield, file and tool manufacturer, left estate of the gross value of £49,584, of which £24,336 is net personalty.

Sir James Brown Marshall, chairman of John Samuel White & Company, Limited, from 1906 to 1917 Director of Dockyards at the Admiralty, who died on July 22, left estate of the value of £26,262.

Mr. J. T. Harris has resigned his position as managing director of Harris Bros., Limited, ship-repairers, engineers, and boilermakers, Swansea. The directors have appointed Mr. J. A. Bonnyman as general manager. Mr. Bonnyman is the son of Mr. James S. Bonnyman, consulting engineer, of Cardiff, and joined the firm of Messrs. Harris Bros. about 18 months ago, having previously been with Smith's Dock Company, Limited, South Shields.

Contracts Open.

Bridgend, September 26.—Supply of iron and lead pipes, pig lead, etc., for the Mid-Glamorgan Water Board. Mr. I. M. Howell, Clerk to the Board.

London, S.E., September 29.—Supply of about 14 tons of solid drawn copper tubing, 1,650 gross of split iron pins, 43,250 wood screws, and 3,019 dozen files. The Director-General, India Store Department, Belvedere Road, Lambeth, London, S.E.1.

London, S.W.1, October 4.—Supply of gas cooking stoves, for the National Gas Council of Great Britain and Ireland. W. J. Smith, secretary, 30, Grosvenor Gardens, London, S.W.1.

London, S.W., October 4.—Supply of 704 axleboxes for wagons, 36,000 fog signals, and rivets, nuts and pins, for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1. (Fee, 10s., not returnable.)

Sofia, Bulgaria, October 7.—Supply of copper tubes, brass rods and wire, etc., for the Bulgarian Directorate of Railways at Sofia. The Department of Overseas Trade (Room 49), 35, Old Queen Street, London, S.W.1.

Deaths.

Mr. Richard Crittall, managing director of Richard Crittall & Company, Limited, engineers, of 197, Wardour Street, London, W., died recently in his 68th year.

Mr. A. J. Evans, who recently died at Wolverhampton, was proprietor of William Evans, Son & Company, brassfounders and manufacturers of locksmiths' requisites.

Mr. Walter Wilson Heron, a veteran shipbuilder of Blyth, has died suddenly at the age of 85 years. Mr. Heron was one of the founders of the Co-operative Shipbuilding Company.

Mr. F. V. Jones, consulting engineer, and a director of Edwin Danks, Limited, engineers, etc., Oldbury, has died at his residence, 80, Reddings Road, Moseley, Birmingham.

Mr. John Alexander Macpherson, director and secretary of P. & W. Anderson, Limited, the contractors, whose death is announced, apparently fell from the train in which he was travelling from Bideford to London.

Mr. Harry Kaye, whose death is announced at the age of 50, had been a member of the Metal Exchange for many years. Born in London, he had been practically all his life identified with the City, and from an early age was associated with the metal trade in various capacities. In recent years he was buyer for a well-known City firm, relinquishing his post to enter into business for himself as a dealer in non-ferrous metals. He established himself in business over a year ago at 12, Fenchurch Avenue. He was formerly connected with H. Koenigs & Company and H. B. Barnard & Sons.

New French Steel.—M. Chafnard, director of the steel laboratory at Imphy (Nièvre) has recently developed a new kind of "steel," the composition and qualities of which have been communicated to the Académie des Sciences by M. Le Chatelier. Into the composition of the new metal enter 60 per cent. nickel, 12 per cent. chromium, 2 per cent. manganese, and 0.5 per cent. carbon. It is claimed to be rust-proof.

Proposed Association of British Engineering Societies.—The President and Council of the Society of Engineers have issued a circular giving particulars of a conference of Engineering Societies which they are convening for September 29 next, to be held at the Engineers' Club, London, at 3 p.m., for the purpose of considering and, if thought advisable, inaugurating the formation of an Association of British Engineering Societies. Some 21 societies have been invited. The Secretary's address is 17, Victoria Street, Westminster. S.W.1.

Port Statistics.—Statistics issued by the Ministry of Transport relating to the working of the principal ports in the United Kingdom show that the total net registered tonnage of vessels arriving with cargoes or in ballast was 12,735,450 last June, as compared with 6,596,470 in June, 1921. As regards vessels departed with cargoes or in ballast in the coasting and the foreign trades, their tonnage last June was 12,864,881, as against 6,500,494 in June, 1921. The average number of days' working in ten leading ports by vessels engaged in the foreign trade varied last June between 1.78 (Swansea) and 5.78 (London), while the number of days lost in port prior to completion of working during the same month in seven leading ports varied between 0.01 (Manchester) and 0.97 (Cardiff), Sundays and holidays excepted.

IRON AND STEEL MARKETS.

Pig-iron.

Reports from the various centres of the industry confirm generally a continuance of the improvement previously noted in the pig-iron trade, which, although admittedly slow, is leading to a gradual expansion of production. In South Staffordshire conditions in the pig-iron market continue firm, although sellers have not been able to obtain the advances they sought when coke became dearer, and are no longer quoting these advanced rates. At the former quotations, however, they are very firm, and there are no concessions to be obtained. The volume of demand remains fairly constant, with recently a slightly increasing tendency. Midland smelters, however, have been helped considerably by the export demand. Their share of it has been comparatively insignificant, but still helpful. At Glasgow recently the demand from America for pig-iron was inclined to slow down a little. In view of the amount of business put through previously this was not unlooked for, but later the demand has regained its former strength, and a considerable tonnage of Scotch as well as Middlesbrough iron has been sold. In fact, unless for some small quantities held in second hands, there is no No. 3 Scotch or Middlesbrough to be bought till after October. Quotations are therefore very firm. On Tees-side sales to the United States, and also to Canada, are still the dominant feature on the Cleveland iron market. A big cargo of foundry iron to special analysis was placed last week, and substantial sales of No. 3 and also of the lower qualities are reported. Meanwhile the home foundries are getting busier, and recently there has been a brisk demand for iron. The effect of these conditions has been greatly to accentuate the scarcity of Cleveland pig-iron, and particularly, of course, of the standard No. 3 quality. Indeed, there is practically no No. 3 obtainable for prompt delivery, and October is generally the earliest date named. It is not surprising, therefore, that the quotation of No. 3 experienced a sharp advance at last week's market, makers asking as high a figure as 95s. per ton. Export inquiry on the whole is rather better, but conditions on the Continent preclude anything like real activity. Quotations are as follows:—No. 1 and siliceous, 97s. 6d.; No. 3 G.M.B., 95s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; mottled and white about 82s.

In the East Coast hematite trade conditions are still disappointing. There has been, it is true, some little improvement of late, but it has not been sufficient to enable makers to lift to any marked extent the heavy stocks still lying on the ground. Only a few small cargoes have been sold to America, West Coast descriptions, with a lower phosphorus content than mixed numbers, being most in favour. West Coast sales may help the East Coast home trade, but so far this does not appear to have been substantially noticeable. Makers are quoting 90s. for mixed numbers, with 6d. per ton more for No. 1, but this is practically a nominal figure, for it is possible to buy, for substantial lots, at 1s. and even more per ton less. Messrs. Gjers, Mills & Company, Limited, who have for some time been running on a single furnace, have now put a second in blast.

Finished Iron.

The manufacturing branches of the iron trade remain as inactive as reported for some time past, a large proportion of the plant being partly idle, or even entirely unemployed, with, so far, few encouraging signs of returning to normal conditions. Some explanation of the present position of the finished iron trade may be advanced in the fact that costs of production are still relatively much higher than in the pre-war period, although the wage rate calculated on the basis of the selling price of the material is now substantially reduced. Railway transport charges are perhaps the most serious impediment to lowering finished iron prices, the recent revision having been altogether inadequate as a stimulus to a more active demand. In the South Staffordshire market crown bars maintain the firmness recently noted, and are not to be bought at less than about £10 15s. to £11; but there is also to be obtained plenty of iron inferior to the crown quality, but superior to the common bar, which sells at round about £10 12s. 6d. Nut and bolt iron realises about 5s. less. Hopes are entertained of an impending revival in the demand for good crown bars owing to reports of an improvement in the engineering trades. The marked bar houses are fairly well employed, but there is no real vigour of demand at £13 10s. (net, f.o.t. makers' works).

Steel.

At Sheffield recently a much more optimistic feeling was expressed concerning the outlook in the great industry of which that district is the centre, and with gradually reviving confidence market movements have evidenced an activity indicating steady expansion of demand for certain qualities of steel material, both for home and export. Among leading lines for which inquiry is in increasing volume are basic billets, but producers of acid qualities could do with more substantial business than is the case at present. Some of the special steels which Sheffield features are slightly more in demand, and with the Government stocks of crucible qualities nearing exhaustion, manufacturers are receiving a larger number of inquiries. The volume of orders from abroad for the cheaper classes of basic steel is steadily increasing, and indicates that German, Belgian and French competition is, though not wholly suspended, by no means keen. Prices continue firm and are unlikely to go below present figures. The fact that there is a slight reduction in the number of unemployed week by week in this district is evidence that the works are better occupied. The heavy branches are the quietest, but railway, electrical and motor-steel sections are better employed, while the tool branches have a fair lot of business on hand. In Scotland, steel bars are in fair demand, but competition for orders is keen, and considerable price-cutting is experienced. The sheet mills are turning out average outputs, chiefly for export, the home market remaining quiet, with buying on a limited scale. Confirmatory evidence of awakening activity in the steel trade is supplied in reports of the ferro-alloy market, especially as concerns home consumers. There is a fair demand for ferro-silicon, but buyers confine themselves chiefly to truck loads, as much through financial stringency as anything else, for while the price seems to be easy, there is little possibility of any real reduction on current quotations. In the tinplate market the orders in circulation are unimportant, and unless an improvement sets in shortly some of the works will have to close down a portion of the mills for want of new business. So far, makers are not pressing sales, and state that values cannot fall materially if cost of production is to be covered. The general tone of the market is poor, and quotations are easy for the standard size as follows:—Coke tins, IC 14 x 20, 112 sheets, 108 lbs., 19s. 1½d. to 19s. 3d. per box; IC 28 x 120, 112 sheets, 216 lbs., 38s. 6d. to 38s. 9d. per box; lights at ¾d. per lb. reduction; crosses at usual extras, net cash, f.o.b. Wales, say October-November delivery.

Scrap.

The slight improvement in the pig-iron trade, noted above, has not yet extended to the markets for scrap metal, which, on the whole, report stagnant if not depressed conditions. In Scotland, however, is found an exception to the general rule, business in the iron and steel scrap trade being fairly brisk, considering the state of trade generally. There are definite signs, moreover, that orders are being received by the works in limited increased numbers, and as a result the demand for all classes of scrap materials should improve. At Middlesbrough the only notable feature in the iron and steel scrap market has been a rather unexpected weakening in the price of heavy steel scrap. There is still a fair demand, but whereas as high a figure as 65s. was recently touched, the price now obtainable is no more than 62s. 6d., delivered works. Supplies of steel turnings and c.i. borings are short, and for the small quantities obtainable 49s. to 50s. per ton is paid. There is very little doing in other descriptions, and prices are approximately as follows, all delivered works:—Heavy cast-iron machinery-scrap, 70s. to 75s.; heavy wrought-iron bushelling scrap, 52s. 6d.; ditto, piling, 60s.; special heavy forge, 70s. to 75s. per ton.

Metals.

Copper.—The tendency of the base metal markets of late has been to more restricted dealings, while fluctuations in values have been generally confined within a very narrow range. Demand for standard copper, however, has lately improved to a slight extent both for home consumption and on the Continent, and weekly sales have been well up to average. Reports from America show no great disposition on the part of producers to make sales of any substantial quantities of nearby metal, but purchases on forward account can be effected at a slight discount. Trade in this country appears to have taken a definite turn for the better, and consumers generally speak with more hopefulness with regard to the future. Current quotations:—*Cash*: Wednesday, £63 5s.; Thursday,

£63 7s. 6d.; Friday, £63 2s. 6d.; Monday, £62 17s. 6d.; Tuesday, £62 12s. 6d. *Three Months*: Wednesday, £63 12s. 6d.; Thursday, £63 15s.; Friday, £63 10s.; Monday, £63 7s. 6d.; Tuesday, £63 5s.

Tin.—Conditions in the market for standard tin disclose little change during the current week, neither buyers nor sellers apparently taking any active interest in day-by-day dealings. There has been some weakening of demand of late in the Welsh tinplate trade, due probably to seasonal causes, and this may account for the corresponding slackness in this section of the metal market. Business with America continues on a restricted scale, but now that the labour situation is more promising, the demand from that quarter should show some improvement. The Straits have sold fair quantities during the past week, but Batavia is holding for higher values. Current quotations:—*Cash*: Wednesday, £159 2s 6d.; Thursday, £159 10s.; Friday, £159 2s. 6d., Monday, £159; Tuesday, £158 15s. *Three Months*: Wednesday, £160 5s.; Thursday, £160 10s.; Friday, £160 5s.; Monday, £160 2s. 6d.; Tuesday, £159 17s. 6d.

Spelter.—The market for this metal continues firm, with values well held. Messrs. Henry Gardner & Company in their report state that, with little metal offering from the Continent, and with the American price above the London parity, the market remains dependent upon the demand from galvanisers for any further advance. Current quotations:—*Ordinary*: Wednesday, £31 12s. 6d.; Thursday, £31 17s. 6d.; Friday, £31 12s. 6d.; Monday, £31 12s. 6d.; Tuesday, £31 12s. 6d.

Lead.—Business passing in soft foreign pig is consistently steady, and the backwardation, recently so much in evidence, has now been reduced. Arrivals from Spain have been on a restricted scale, whilst supplies from Mexico have also been curtailed. The demand from consumers is being fairly well maintained, sheet and pipes makers taking fair quantities. Current quotations:—*Soft foreign (prompt)*: Wednesday, £24 7s. 6d.; Thursday, £24 7s. 6d.; Friday, £24 7s. 6d.; Monday, £24 10s.; Tuesday, £24 7s. 6d.

New Process of Finishing Welded Pipes.

A new process in the finishing of butt-welded pipes is described by Mr. F. N. Speller (metallurgist of the National Tube Company, U.S.A.), who points out that while there have been many improvements in appliances for butt-welding pipe, the method of finishing has not been materially changed for some time. The new process involves welding the pipe larger in size than was formerly necessary, then after one rounding-up pass, the temperature of the pipe is reduced to a little above the annealing point (about 1,800 deg. Fah.), after which the diameter is further reduced by passing through several rolls to the finished size. The straightening and cooling operations are then carried out as heretofore. The object of these additional rollings is primarily to remove the welding scale from the pipe, especially from the inside, so as to lessen the tendency for pitting and facilitate galvanising or the application of other coatings. Incidentally, this additional work done on the steel tends to improve the material and the weld.

The standard method of finishing pipe formerly consisted in giving the pipe one pass through a circular sizing roll and one pass through straightening rolls of helical section and then cooling on a travelling table. The finished pipe was covered with a rather heavy mill scale formed in the heating furnace at the welding temperature. This scale consisted essentially of iron oxides, principally Fe_3O_4, with 7 or 8 per cent. of silica and smaller amounts of CaO and Al_2O_3 from the furnace bottom. At the welding temperature this scale was fluid and formed a natural flux for welding, as well as a protection to the metal against excessive oxidation from furnace gases, so that this was a very essential factor in the welding of pipe, so much so that pipe steel was made primarily so that it would be self-fluxing by readily forming this fluid oxide at as low a temperature as possible.

Several means have been used to remove this scale to prepare the pipe for galvanising and other coating operations. Pickling in acid is the most common method employed. Mechanical cleaning by sand blasting and cold rolling has also been tried, but has not been thorough enough, besides being costly.

By making the diameter of the pipe larger and then reducing its size and elongating the pipe at the highest temperature at which the scale is brittle enough to remove, it has been found possible to clean the pipe in the process of hot finishing and at the same time produce a better material in other respects. This new process of finishing is very advantageous. It will be seen that two additional steps are introduced in the finishing operation in order to produce what is practically a scale-free pipe, (1) a partial cooling from about 2,500 to 1,800 deg. Fah., (2) a reduction in diameter and elongation of about 10 per cent. in length by means of a series of horizontal and vertical rolls, by which the brittle scale is cracked and separated from the steel. The pipe is then straightened and cooled as usual, during which a thin film of new oxide forms sufficient to protect the metal from rusting while being handled. A thin coating of suitable lacquer is now applied, which affords substantial protection to the pipe in storage. The main object of these scale-removing and cleaning operations is to make possible more uniform galvanising. This also has an important bearing on the manufacture of all kinds of coated pipes and conduits for electrical purposes.

The surface rusts much more uniformly when scale-free than when covered with the heavy mill scale, as there is an appreciable current generated between mill scale and iron which results in pitting of the metal. For this reason it is usually of advantage to have the scale removed, especially where the pipe is buried in the ground or subject to other active corrosive agents. The fact that mill scale is usually the controlling factor with respect to pitting of iron and steel has been demonstrated by several other investigators.

The scale-removing process described was first developed in 1913, and has recently been put into general use in the butt-welding mills of the National Tube Company. In hot galvanising a saving of considerable time and about 50 per cent. of the acid has resulted from the use of scale-free pipe as well as a much improved product, particularly with respect to the inside coating.

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Contents.

	PAGE
Co-operation in Research	253
Electric Furnace Developments	253
The Institute of Metals	254
The Luxemburg Iron and Steel Industry in 1921	256
McConway Centrifugally Cast Steel	257
Grain-size and Diffusion	258
The Structure of Eutectics	258
The Copper-rich Aluminium-copper Alloys	258
"Metallic Phosphors"	258
An Apprenticeship Course in Foundry Practice—XI.	259
Chelsea Polytechnic	261
Making Steel without Pig-Iron	261
A Study of the Weight of Iron Castings	262
White Metals	265
Contribution to the Discussion on Mr. Smalley's Paper on High Tenacity Brass and Bronze	267
Correspondence	267
The Institution of Production Engineers	267
Trade Talk	268
Institution of British Foundrymen	268
Formation of a Section of the Institute of Metals at Swansea	268
Iron and Steel Markets	269
Gazette	270
Company News	270
Contracts Open	270
Publications Received	270

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Co-operation in Research.

The tendency for research to be a monopoly of the academician, or the physical chemist, cannot have failed to be noticed by all progressive foundrymen. This state of affairs is due primarily to his special training, and secondarily to the precision apparati at his disposal. It does not follow that the results obtained from this class of work are of more value to the trades concerned than those given by the technical or even the practical man, because the highly-finished work of the research student is often a statement of facts, the propounders of which do not know or at least are afraid of giving their practical application. This was dealt with last week at the Swansea meeting of the Institute of Metals, by Sir Henry Fowler, who pleaded on behalf of the practical man to the newer schools of professors to indicate clearly the data capable of being translated by the departmental manager into actual practice. If a paper is without any practical interpretation then it might be so stated, so that the practical men associated with the various institutions can better occupy themselves than by listening to a discussion from which there is little change of their deriving any benefit beyond a lesson in the art of mutual congratulation. If real benefit is to be obtained by owners and managers from spending several days away from their works, then the councils of the various technical (not the academical) societies should insist that the practical bearing of the papers must be clearly emphasised, or if the high-brows insist on arguing abstruse points, then perhaps it would be well to follow the American system and hold simultaneous meetings, so that those in charge of manufacturing processes will have a chance of eliciting and giving information helpful to the work in hand, and not something which might be useful in ten years' time. At this period, perhaps, it may be found that the research worker has so come down to earth that he is capable of successfully controlling manufacturing processes. At the moment, however, manufacturers prefer to employ technical men—men who should be capable of economically utilising the results of published and his own research work through the medium of his foreman, skilled men and labourers.

In some sections of the metallurgical industries well-informed departmental managers are hesitating to give papers or contribute to discussions because of their lack of training in the higher branches of modern physics, and fear the criticism of those so versed. We can assure them that it is the absence of practical knowledge which restrains the research worker from hazarding any application of his work to practice. Therefore the timidity is mutual.

The foundry trades can congratulate themselves that of all societies their representative technical association is the best in so far as catering for the actual workers is concerned, for when highly-scientific papers have been presented, the lecturers have been careful to point out the practical bearing.

No doubt, in the future, the Institution of British Foundrymen will accept a limited number of academical contributions, but we believe that before their advent a number of educational papers which have been and will be presented, will overcome the objection sometimes raised by the research worker that "It is not our fault if managers are sufficiently educated to understand our investigations." Speaking for the foundry end of the metallurgical industries, we feel sure that the intensive application of old-fashioned elementary chemistry, physics, and mathematics will do infinitely more good than any wild-cat chase into the realms of their higher branches.

Electric Furnace Developments.

Mr. Frank Hodson, president of the Electric Furnace Construction Company, of 908, Chestnut Street, Philadelphia, Pa., and until lately also associated with Messrs. T. H. Watson & Company, of Lancaster Street, Sheffield, recently sailed for the States.

During his visit to Europe he negotiated the representation of the Grönwall electric high furnace for many parts of the world. His firm are busy with the construction of 100-ton electric furnace for the Ford Motor-car Works. It is to be based on the Greaves-Etchell system, and will carry eight 12-in. graphite electrodes. It is to be used for refining only—not for melting.

The Institute of Metals.

AUTUMN MEETING AT SWANSEA.

The autumn meeting of the Institute of Metals was held in the Llewellyn Hall of the Y.M.C.A. from Tuesday, September 19, to Friday, September 22, under the Presidency of Mr. Leonard Sumner, O.B.E., M.Sc.

First Day.

The first annual lecture on subjects of practical interest to those engaged in the non-ferrous metals industry was delivered in the evening by Dr. R. S. Hutton (Member of Council), the subject being: "The Science of Human Effort (Motion Study and Vocational Training)."

Second Day.

The general meeting of members was opened in the Llewellyn Hall of the Y.M.C.A., the President (Mr. Leonard Sumner) occupying the chair.

Civic Welcome.

The Mayor of Swansea (Alderman William Owen, J.P.) said that on behalf of the Aldermen, Councillors and Burgesses of Swansea he extended a most hearty and cordial welcome to the members of the Institute. Swansea was an old town of great importance, its prominence being largely due to the industries and trades in which it was engaged. The metallurgical trades of the country and the industries concerned with them, copper smelting in particular, had placed Swansea in the proud position of being the greatest metallurgical centre in the world. That statement might be challenged, but nevertheless it was true. The Vivian family were the early pioneers of the metallurgical trade of the port of Swansea. The ores at that time chiefly came from Cornwall, but the demand was so great that they recognised, in a very short time, that Cornwall alone could not supply the ores required. With the opening up of the Chilian and South American trade Swansea began to develop very rapidly indeed. Swansea had also made great progress in a scientific direction. The system of education in Swansea at the present time lent itself in every respect to the further development of the trade which had done so much for the town. Swansea possessed a very fine elementary system of education; it also possessed a Technical College, a School of Art, and last, but not least, the University College. During the visit which the members would pay to the University College they would have the opportunity of seeing some of the most efficient and up-to-date laboratories in the country, under the distinguished control of Professor Edwards.

Dr. T. Franklin Sibly (Principal, University College of Swansea), in voicing the welcome of the educational authorities of the town, said he very much regretted to state that owing to an important business engagement Mr. Gilbertson, the President of the University College, was unable to be present to receive the members.

Mr. H. Lang-Coath (Town Clerk) also added a few words of welcome to the members.

The President thanked the Mayor, Dr. Sibly, and the Town Clerk for the very cordial and hearty welcome that had been extended to the members on behalf of the Borough of Swansea. He thought the Mayor was quite right in claiming that Swansea was the biggest metallurgical centre in the world. He made that remark with all due deference to the gentlemen who came from Birmingham and elsewhere. Modern non-ferrous metallurgy was founded by the Vivian family somewhere about 80 years ago. Swansea was a most important centre, its industries comprising copper, nickel, silver, gold, spelter, and tinplates, the latter of which he thought might be claimed as a part of the non-ferrous industry. He thanked the Mayor for sparing a few minutes of his valuable time to attend the meeting, and for the cordial and hearty reception that he had given to the members.

Nomination of Officers.

The minutes of the last general meeting were taken as read, and confirmed.

The Secretary announced that as a result of the ballots that were held in July and September the following 37 members and 15 students were found to be duly elected.

The Secretary read the following list of Council nominations for the offices for 1923:—

President: Mr. Leonard Sumner. Vice-President: Mr. W. Murray Morrison (new nomination), Sir Thomas Rose, retiring vice-president, who was eligible for re-election.

Members of Council (six vacancies): Mr. T. Bolton and Mr. G. A. Boeddiker (new nominations), Engineer Vice-Admiral Sir R. B. Dixon, Professor C. A. Edwards, Mr. S. Everett and Mr. H. B. Weeks (retiring members, who offer themselves for re-election).

The President announced that the result of the ballot would be declared at the annual general meeting, to be held on March 7 and 8, 1923. According to the articles, Section III. (16) in ten numbers might also at that meeting nominate a candidate other than the ones just nominated by the Council.

Sixth Report to the Corrosion Research Committee.

By Guy D. Bengough and J. M. Stuart.

The aim of this Report is to present a general discussion of corrosion phenomena, based on the study of several different metals, and to examine how far the electro-chemical theory of corrosion (usually called the electrolytic theory) can account for the observed phenomena. The difficulties encountered by this theory are indicated, and it is shown that it gives a satisfactory account of the facts only under certain conditions, while many facts can only be explained by recognising the important part played by colloids in corrosion. A theory of the mechanism of colloid action is put forward, and some experimental results are reviewed in the light of this theory.

As regards the effect of impurities on the corrosion of metals a trace of impurity appears to assist local corrosion, but the amount of corrosion is not proportional to the amount of impurity. Even the presence of graphite does not appreciably stimulate the rate of corrosion of iron. The effect of a trace of impurity is probably a trigger action.

On the electro-chemical theory the action of oxygen is that of a depolariser. It can be shown, however, that atmospheric oxygen has very little depolarising power at ordinary temperatures. The main function of oxygen in corrosion is to oxidise directly the metal, and also in some cases the products of corrosion.

Two chief types of corrosion are distinguished: (1) The general type, usually characteristic of acid corrosion; (2) the local type, usually characteristic of corrosion in water and salt solutions. The second type is generally characterised by the formation of an adherent scale on the metal, and this scale may contain colloid.

Discussion.

Professor H. C. H. Carpenter, in opening the discussion, said that since the work of the Committee was inaugurated 11 years ago, it had followed two main directions; on the one hand, the strictly practical problem of determining the causes of corrosion on marine condenser tubes, and, on the other hand, the elucidation of the broad aspects of corrosion itself. In the early days the former problem was the one chiefly attacked, and the first three reports dealt mainly with that aspect of corrosion phenomena. In the Fourth Report, however, the members received the first real indication that it was necessary to go outside the study of that particular problem, and to ascertain more fundamentally what corrosion really was. In the Fifth Report a return was made to the practical aspects of the question, and following upon that a pamphlet was published at

the last meeting of the Institute, which presented in compact form the results of all previous work. He also desired to say that the Committee had been very much encouraged by the increase in the contribution which was paid to the Institute by the Brass and Copper Pipe Association, which had increased its contribution from £300 a year to £500 a year.

Moreover, they had the satisfaction of knowing that the Department of Scientific and Industrial Research, which gave a large grant towards the work, really gave their aid to investigations of a fundamental character with the greatest pleasure. It might therefore be said that a stage had now been reached when the value of the work was becoming more and more widely recognised, and a position had now been reached where they had, so to speak, touched bottom. It was impossible to have anything more fundamental than the present Paper. To what extent it would survive the work of future investigators only the future could show, but at any rate Dr. Bengough and his collaborators had led the members to the point which fundamentally required investigation. The authors indicated that no metal was really inoxidisable, and that the number of things which could happen to the inside film was very considerable, so that it might be wondered whether after all the problem would ever be solved. If that was the impression which the Paper gave, he would like to say, for what it might be worth, that he did not share the view which was held that a solution of that particular problem would not be reached.

In conclusion, he desired to say that he thought the Report under discussion would prove to be the most important Paper that had yet been published under the auspices of the Institute. But he also thought it would be some time before its full effect was felt. That was the test as a rule of a good piece of work, and although he was not inclined to prophesy to any extent, but really thought that the experimental data in the Report and the presentation of the authors' views would ultimately become a classical contribution to the phenomena of corrosion.

Electro-Chemical Theory Advanced.

Mr. U. R. Evans expressed satisfaction that the authors of the report laid stress on the physical character of the corrosion product in determining the persistence of corrosion. The oxide coat that generally existed upon aluminium was almost as good a protective covering as a layer of nickel or silver, but in other cases the corrosion product was non-adherent, and afforded no protection. Certain reagents, notably chlorides, tended to loosen the products and prevented it from shielding the metal effectively. Their action seemed to be governed by the same universal physical principles as the action of soap in removing a grease film from metal. Everyone knew that it was difficult to remove a grease film by rubbing with pure water, since the removal of the grease from the inter-face into the water would involve an increase of the inter-facial energy of the system, and this had to be provided as the mechanical energy of scrubbing. If, however, the soap was added to the water the case was different; the inter-facial energy at the boundary between grease and soap solution was small, and the removal of the grease from the surface in small globules into the soap solution involved no increase of energy, and proceeded quite easily. Similarly, the oxide film existing on many metals was closely adherent when they were immersed in pure water, but if chlorides were added to the water the separation of the oxide from the metal involved no increase of inter-facial energy, and the corrosion product tended to be of a loose character. Hence the importance of chlorides in preventing the passivity of metals. It was noteworthy that those metals which, like iron or nickel, had oxide soluble in acid and insoluble in alkali, tended to become active in the presence of acid and passive in the presence of alkali. Metals, like tungsten or molybdenum, which had oxide soluble in alkali, but almost insoluble in acid, tended to become passive in an acid solution, but were rendered active in an alkaline solution. Turning to the question of whether corrosion was chemical or electro-chemical, it would appear that since the atoms were certainly electrically charged in the combined state, corrosion was essentially a passage from the uncharged to the charged condition, and consequently an electrical factor must be involved; in this sense, even the so-called "direct chemical attack" was really electrical. The type of electro-chemical corrosion which was associated with the production of distinct anodic and cathodic areas was, however, another matter, and it was a question still requiring experimental investigation. The difference between this electro-chemical corrosion and direct-chemical corrosion was that in the direct-chemical type the metal would only be attacked at those points to which the oxidising agent, usually dissolves oxygen had direct access; in the electro-chemical type corrosion might occur at places to which the oxidising agent had no access. It was clear, however, that corrosion often proceeded most rapidly at those points to which the dissolved oxygen had least access, as for example, at the bottom of pits or where the metal was shielded by string, cotton wool, wax or permeable corrosion products. None of the chemical theories of pitting explained how the oxygen was at the bottom of a deep pit, whereas if corrosion was attributed to a difference of potential between the aerated and unaerated portions, it could be said that the metal entered the ionic state at the unaerated portion within the pit, forcing out upon the parts of the surface outside the pit, hydrogen which was removed by the oxygen there present. There was another line of argument which lead in a logical manner to the conclusion that much of the corrosion met with in practice and which the authors attributed mainly to chemical action, was to a great extent of the electro-chemical type. He was surprised that they laid so much stress upon the fact that the hydrogen produced by the action of water upon zinc was invisible even under the microscope.

It would be asked why oxygen should diffuse towards commercial spelter quicker than towards Brunner-Mond zinc, or why it should diffuse quicker towards cast than wrought iron. Of course, in certain specially-made material, such as Lambert's iron, the uniformity must be such that the hydrogen was not produced so quickly as it was used up, but such materials were quite exceptional, and could not be obtained without taking special precautions. It seemed clear, therefore, that the rate of corrosion where oxygen was present was largely independent of the purity of the material and of the conductivity of the solution. The different behaviour of the different metals was dictated not so much by their position in the potential series as by the solubility and physical character of the corrosion product under the conditions in question. The action of non-oxidising acids upon reactive metals was however governed by quite different laws, because here the hydrogen was evolved in bubbles, and the question of oxygen diffusing did not enter in. Accordingly, in dilute hydrochloric or sulphuric acid, cast-iron dissolved more quickly than the so-called open-hearth pure iron. The dissolution of metals in acid was much more rapid than in neutral solution, and accorded rather better with the position of the metals in the potential series, but there was still one complicating factor, namely, that remarkable super-saturation phenomenon which was known to electro-chemists as over-voltage.

Over-Voltage.

Pure zinc was hardly ever attacked by acids owing to its high over-voltage, but certain impurities, and especially metals which were more noble than zinc, and which had low over-voltage values had a remarkable accelerating action. Of course, they could only act as cathodic areas when present as a separate phase. If uniformly distributed in solid solution, they had no immediate influence. But all the noble impurities in zinc, whether present in solid solution or between the grains, appeared as a black scum on the surface of the metal as attack proceeded. This gave an explanation of the so-called period of induction observed in the corrosion of zinc. When zinc was first immersed in acid the attack was slow, but as the black scum, consisting mainly of lead and cadium, appeared on the surface dissolution proceeded faster and faster. It was found that if the black scum was removed the rate of attack dropped again, a fresh period of induction being observed.

It would seem, therefore, that the difficulties raised by the authors of the report largely disappeared when the matter was closely investigated. The authors gave a number of cases which they stated was difficult or impossible of explanation on the electro-chemical theory, but it appeared to him that in none of those cases was an electro-chemical interpretation definitely excluded. There was not time to discuss them in detail, and further work was required to decide the relative importance of chemical and electro-chemical corrosion.

Nomenclature Requires Simplification.

Mr. W. H. J. Vernon said that his main object in entering the discussion was to put in a plea for the simplification of corrosion nomenclature, the need for which no one familiar with corrosion literature would dispute. Excluding for the moment considerations of colloidal phenomena, it might fairly safely be said that the alternatives in regard to initial action in aqueous solutions boiled down to two only. Either the metal passed into solution in the ionic condition in virtue of its electrolytic solution tension, or the surface of the metal was attacked by molecular oxygen already present in solution. These two cases were exemplified in the report, and the behaviour of the corrosion products as indicated in the text followed readily from considerations of their mode of formation. To his mind it seemed highly desirable that the scheme of nomenclature should clearly differentiate between these two fundamental types of initial action, and he confessed to that in the present connection this was all that appeared necessary to do. The authors had got the latter type safely fixed up, this constituting the direct oxidation dealt with in the fourth report. The term "electrolytic" was in very common use, and, personally, he could see no objection to applying this term to any case where a metal passed into solution ionically, *i.e.*, in virtue of its solution tension. This suggestion would get rid of such terms as "acid theory," "carbon dioxide theory," etc., with which, unfortunately, the literature of the subject abounded. These terms were frequently misleading, and at the best were merely redundant, and he thought the time had come when a serious attempt should be made to do away with them.

Corrosion of Boats.

Referring to the particular case of electrolytic action where there were definite anodes and cathodes, which admittedly was the usual state of affairs where continuous corrosion was proceeding, the term "galvanic couple" was available. This term was in common use by chemical authorities, and for the present purpose seemed preferable to the term "electro chemical," since the latter was very frequently used synonymously with electrolytic. The galvanic couple type of electrolytic action for the purpose of emphasising its importance in corrosion phenomena. While this action naturally flourished most in acid liquids, it occurred quite frequently in neutral solutions. As an example of internal or local surface action it might be mentioned that certain alloys of zinc with tin and copper corroded rapidly in distilled water, and it might readily be arranged for the displaced hydrogen to be collected. With regard to the external type of couple action, very many examples could be quoted from practice. Some years ago legal action was taken over the wholesale damage due to iron ships in Leghorn Harbour through the presence of copper-bottomed yachts, electrical connection being afforded through hausers and buoys. The electrolytic theory was then vindicated to the extent that the copper-bottomed vessels had to be removed from the harbour. Coming to more recent times, a case was described only last year before the American Electro-Chemical society of a schooner cased with plates of monel metal. Contact of this metal with the steel rudder-frame and other exposed steel parts took place, which resulted in their rapid corrosion—so rapid, indeed, that the ship was broken up without having made a single voyage.

Author's Reply.

Mr. J. M. Stuart, in reply, thanked Professor Carpenter for the kind remarks he had made on what the authors considered was a somewhat speculative Paper. He had been greatly interested in Mr. Evans's defence of the electro-chemical theory. One point, however, which Mr. Evans passed over, which had always puzzled him in connection with that theory, was how the pacifying effect of dichromates could be explained. With regard to Mr. Vernon's criticism, they did not deny that electro-chemical oxidation could take place in neutral solution, but in cases where it did occur in neutral solutions the voltage between the two elements was quite considerable, and the two elements which were corroding, corroded quite differently from corrosion which occurred when they were separated. He proposed to leave Dr. Bengough to deal with the remainder of the points that Mr. Evans had raised.

The President said that owing to the shortness of time available he proposed to ask Dr. Bengough to put his reply in writing. In proposing a hearty vote of thanks to the authors for their very interesting Paper, he wished to say that when he first tried to read the Paper his heart sank, because he thought a new conclusion was arrived at by the authors. The members of the Institute wanted to find out why condenser tubes corroded, and he thought when he read the Paper that they were as far off from anything as they ever were.

The Effect of Superheated Steam on Non-ferrous Metals used in Locomotives.

By Sir Henry Fowler.

Superheated steam is now generally used on locomotives, the steam usually leaving the superheater at a temperature of 340 deg. C. Not all the parts mentioned are subjected to this continuously as the steam expands, and in so doing falls in temperature. The practice referred to is that adopted on the Midland Railway. The parts dealt with are:—(1) Piston tail rod bushes, (2) piston rod packing, (3) piston valve fittings, (4) cylinder relief valves and (5) by-pass valves.

The President said that although none of the members present seemed desirous of discussing Sir Henry Fowler's Paper, he hoped that some of them would send in written communications on the subject. In the meantime he proposed that a hearty vote of thanks be accorded to Sir Henry Fowler for the trouble he had taken in preparing the Paper.

White Metals.

By A. H. Mundey, C. C. Bissett, and J. Cartland.

An abstract of Part I. of this Paper dealing with bearing metals will be found on another page.

The Luxemburg Iron and Steel Industry in 1921.

The iron-ore exports declined from 2,042,889 tons in 1920 to 1,668,582 tons last year. Those to occupied Germany fell from 475,061 tons to 444,781 tons, to Germany itself from 827,602 tons to 698,998 tons, and to Belgium from 551,768 tons to 357,776 tons in the two years. On the other hand, the imports from France increased from 965,124 tons in 1920 to 1,054,447 tons last year.

With regard to the production of iron and steel, the report states that while the pig-iron output declined in neighbouring countries, it showed an increase in the Grand Duchy. The Luxemburg works took advantage of the facilities offered by the coke market to increase production, so as to reduce first costs and at the same time prevent unemployment. Out of the 47 furnaces, from 18 to 23 were in blast, as against from 17 to 19 in 1920, and the output was 970,336 tons of pig-iron, as compared with 692,935 tons in 1920. Of the 1921 output 79,223 tons were foundry pig-iron (62,204 in 1920), 890,438 tons were basis Bessemer pig (630,161 tons), and 675 tons forge pig (570 tons). The average price of the total output was 246.57 fcs. (say 98s. 6d.) per ton, as compared with 551.03 fcs. (say 220s.) in 1920.

The production of steel ingots at the seven steelworks in the country increased from 569,545 tons in 1920 to 750,974 tons last year, and the average price per ton declined from 755.37 fcs. (say 302s.) to 292.73 fcs. (say 117s.) in the two years respectively.

McConway Centrifugally Cast Steel.

One of the features of the recent Iron and Steel Institute meeting at York was a film demonstration in the Festival Concert Room on Tuesday afternoon by Mr. William McConway, of Pittsburgh, descriptive of the new McConway process for the production of steel discs by centrifugal and hydraulic methods direct from molten steel. Mr. McConway is the head of the well-known McConway and Torley Company, of Pittsburgh, U.S.A., who are perhaps best known in this country as the makers of the coupler for railway wagons which bears their name, and who operate steel foundries in connection with this and other specialities, and also have steelworks and rolling mills.

The principles of the McConway process, if they work out in practice with the economies which the inventor anticipates, will be just as revolutionary in the handling of steel from the molten condition to the finished product as were the Bessemer and Siemens processes in the production of liquid steel. The process has been evolved as a result of six years' experimental work, some of which was held up owing to the exigencies of war service, but has now reached the stage where it has been definitely proved successful so far as the practical difficulties of the process are concerned. Mr. McConway originally developed his process as an adjunct to his steel-foundry practice, *i.e.*, the steel cylinders were cast in ordinary sand moulds, and were afterwards further manipulated with a view to producing tyre blanks and thereafter tyres, turbine discs, and other products of a similar nature. It is not, of course, necessary to dwell upon the heavy loss in metal in the form of scrap which occurs in the production of a tyre by the present process of forging the "cheese," cutting out the centre, and thereafter rolling it to a tyre. The loss in the centrifugal process is about 5 per cent. only.

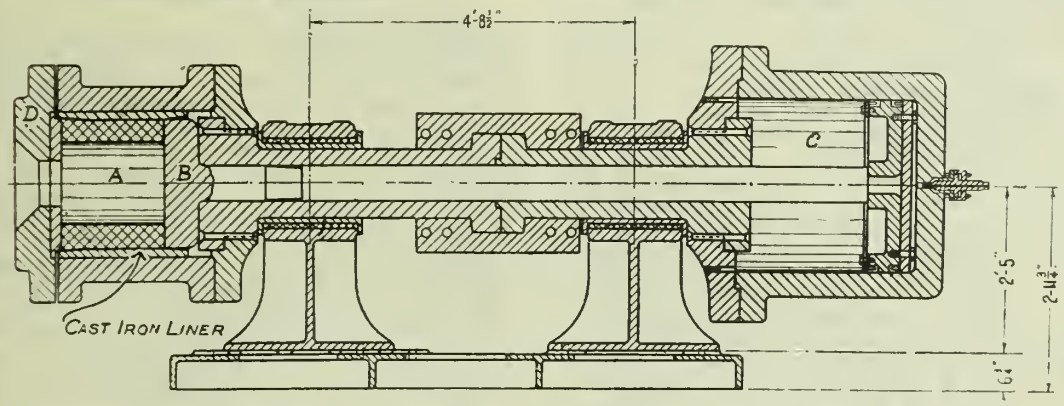
The chief claim of the McConway process for tyre blanks is the large saving in metal which it effects. Mr. McConway has, however, carried the process a step further, and claims to produce centrifugally cast rings which can thereafter be cut into standard billets, and these billets used for rolling merchant products. His view is that this process can be reduced to such a cost that it will be possible to produce even the cheapest forms of rolled steel, *i.e.*, ferro-concrete bars, from centrifugally cast billets, and it need hardly be said that if these views are borne out by further experience, the blooming mill will (in some lines) be a relic of the past, and much future steel practice will proceed direct from the centrifugally cast semi-product to the finishing mill.

The chief element of the McConway process is a centrifugal hydraulic casting machine, of which a section is shown herewith. It will be seen that this consists of a cylinder A, in which the castings are made, a piston B fitting into this cylinder, and a hydraulic cylinder C. The ingot metal from the furnace is tapped in the ordinary way into a ladle, which is brought to the machine, and the metal tapped through the runner into the casting cylinder A through the detachable casting head D. During the process of feeding the metal and casting, the machine is rapidly rotating, the peripheral speed in the casting cylinder being approximately 65 ft. a second. The effect is that the metal is immediately forced to the periphery of the cylinder, and forms a cylindrical or ring-shaped ingot.

The cylinder is fitted with a cast-iron liner, and the piston B is of steel with a cast-iron face, so that the whole cylinder against which the metal is cast is lined with cast iron, there being also a cast-iron liner on the detachable head. In the matrix at present in use the diameter of the cylinder inside the cast-iron liner is 30 in. In the forging-press operations, which follow next, this diameter is usually increased, say up to 38 in., or less if desired, the diameter of the central hole as required being the governing factor.

The length of the casting cylinder is 12 in. Immediately after the metal is poured into it the piston B is slowly advanced, and the cylinder of metal by this means is compressed during the cooling from its initial length of 12 in. to about 10½ in. The whole process takes from 15 to 17 minutes. Approximately two-thirds of this time is taken up with casting, centrifugalising and solidifying the cast, and the other third in removing it to the soaking pit.

Hydraulic End.—The other end of the press consists of an ordinary hydraulic cylinder, which through its piston and rod operates the casting cylinder piston. A feature, however, of the invention, and a mechanical contrivance which has rendered the process possible, is the stuffing box. The great difficulty arose in getting hydraulic pressure into a cylinder rotating at this speed. The solution was the stationary hydraulic pipe, leading through the stuffing box on the outer end of the hydraulic cylinder and revolving in the pipe end, as on a nipple; orifice, 0.11-in. diameter. The usual water pressure is 500 lbs. per sq. in., but pressures up to 1,200 and 1,400 lbs. have been employed.



Longitudinal Section of the McConway Centrifugal Hydraulic Casting Machine.

We understand that this machine has given every satisfaction from a mechanical point of view in the casting of these centrifugal cylinders. Cast-iron liners have been found to be the most suitable material with which to line the casting cylinder, and owing to the shrinkage of cast steel of approximately ¼-in. to the foot, there is, of course, no difficulty about ejecting the cylindrical ingot of metal when cast.

After being ejected from the press, the ingot is taken to a soaking pit and then finished under an ordinary hydraulic press, one of 2,000 tons being at present used for this purpose. It is then still further forged as may be necessary.

It follows that in this centrifugal casting process the metal at the periphery of the ingot is exceedingly dense and free from slag inclusions. The slag, being lighter, concentrates in the inside circumference of the casting, and it has been found advantageous to broach the hole in the "cheese" just before the last pass in pressing. A very light cut will remove practically all the slag inclusions. The further treatment of the ingot, therefore, which has previously been kept in a soaking pit and brought again to a forging heat, includes this broaching of the centre core

The chief claim of the McConway process is, of course, the reduction in discard, which, as all steelmakers know, is a very large one when figured from ingot weight to weight of finished product, either in tyres, rails, or bars. The metal obtained is also very homogeneous and free from segregation and slag inclusions. Beyond this it is not claimed that the metal is stronger or more ductile, *i.e.*, bars produced from billets made in this way would average about the same in strength and ductility as bars made from ingots of the same composition in the ordinary way. Its application to low-priced products, such as merchant bars, involves questions of capital outlay which have not yet been fully examined. Mr. McConway, indeed, has not as yet made any decision as to how he proposes to deal with the process from the financial standpoint. The purpose of the exhibit given was mainly to acquaint the trade with what had been done mechanically in developing this new process.

The agents of the American firm are Messrs. W. Bayliss and Company, Limited, 240, Dashwood House, New Broad Street, London, E.C.2, through whom communications to Mr. McConway may be addressed.

Grain-size and Diffusion.*

By Professor J. H. Andrew and Robert Higgins.

Experiments have been conducted which show the relation between grain-growth and diffusion. Diffusion at high temperatures may take place simultaneously with grain-growth, whilst at low temperatures diffusion promotes a breakdown in the grain-size. These results have been applied to the annealing treatment of commercial castings. A suggestion has been advanced to explain the atomic arrangement existing at the grain boundary. It has been assumed that in the interior of the crystalline grains the system of closest packing holds, whilst at the boundaries, the atoms in the separate grains touch only at one part of the circumference. This explains the decrease in specific gravity with an increase in the number of grains, for in such an arrangement certain free spaces must occur. Plastic deformation, by shifting the atoms in certain grains from their position of equilibrium, will cause these atoms to rearrange themselves when heated to a sufficiently high temperature; this rearrangement will be so brought about, that the stressed atoms will fall in with, row for row, the unstrained atoms of the adjacent crystal, thereby effecting a gradual migration of the grain boundary. Such a rearrangement may proceed from every side of a crystalline unit, resulting in one grain being divided up and being absorbed by others. The final bounding surface will result when a state consistent with that suggested for the boundary configuration finally results. A suggestion based upon the Langmuir idea of valency has been given to explain the migration of a separating phase to the grain boundary.

The Structure of Eutectics.*

By F. L. Brady.

This Paper deals with the structures exhibited by eutectics, mainly those between metals and metallic compounds. An attempt has been made to correlate the microstructure of a solidified eutectic with the physical properties of the component metals. The surface tension of the molten metal and the cohesive force acting during crystallisation seem to be the main forces influencing the final structure. The eutectics examined, which include those between metals whose physical forces are known, fall quite decidedly into three classes. The terms "globular," "lamellar" and "angular" have been suggested as convenient terms for these divisions. The structures agree well with what would be expected from theoretical considerations of the effects of surface tension and cohesion. Photomicrographs are given of characteristic structures of the various alloys examined, and an account is given of the methods of polishing the alloys, and a list of the etching reagents found most suitable.

* Papers read at the Autumn Meeting of the Institute of Metals.

The Copper-rich Aluminium-copper Alloys.*

By D. Stockdale.

The structures of the alloys of copper with aluminium up to 20 per cent. of aluminium have been investigated by the author, who used the thermal data supplied by a study of the cooling-curves of the alloys and by quenching experiments in conjunction with microscopic examination in order to obtain the equilibrium diagram more exactly. He discredits the opinion that the addition of small quantities of aluminium to pure copper raises the freezing point of that metal, and shows that the minimum in the liquidus curve at 1031 deg. C. with 8.3 per cent. of aluminium is a true eutectic point. A small arrest point at 1017 deg. with alloys containing between 16.5 and 18 per cent. of aluminium has been discovered, but there is no indication of a minimum in the liquidus at about 16 per cent.

Copper, at 1000 deg. C., can hold only 7.4 per cent. of aluminium in solid solution; at 500 deg. C. and at lower temperatures it can hold 9.8 per cent., although to obtain such an alloy a long annealing is required. The beta solid solution breaks down above 535 deg. C., and Andrew's observations on the gamma and delta constituents have been confirmed. That portion of the diagram concerning the beta and gamma field has been radically altered.

"Metallic Phosphoro."

Metallic Phosphoro is a material admitting of application in both the iron and brass foundry. In the former its function is that of a flux. The manufacturers claim that it increases fluidity and produces a well-mixed iron free from porosity due to metal defects. Obviously those arising from sand troubles and wrong gating cannot be cured by any sort of deoxidiser. It is claimed to be specially useful for warming up cold heats, the manufacturers suggesting the use of 1 oz. per cwt., the "phosphoro" being placed in the ladle before teeming. If, as the name suggests, it contains considerable quantities of phosphorus, its oxidation to phosphorus pent-oxide would evolve a considerable quantity of heat, being an energetic exothermic reaction. The resultant oxide of phosphorus would rise up to the slag, having a low specific gravity. We doubt whether, unless used in excess, the phosphorus content of the mix would be increased. A further advantage claimed, which must be due to exothermic reaction, is the better incorporation of silicon as ferro-silicon. Unless an initial good heat is available, ferro-silicon can be difficult as regards its even dissemination throughout the metal, especially if lumps of too large a size are used. Powdered ferro-silicon is liable to rest on the slag.

Use in the Brass Foundry.

Metallic Phosphoro is claimed by the makers to increase density, fluidity, strength, and diminish shrinkage, sponginess, cold sheets and blow holes. As a partially substitute for tin in Government bronze or gun-metal, "metallic phosphoro" has, it is claimed, been pronounced by the United States Government as being specially successful. In a mixture containing 2 per cent. or less of tin, all the tin may be replaced by one-half of the amount thus omitted in "metallic phosphoro" and the remaining half in zinc. Thus, an alloy containing 70 per cent. Cu., 2 per cent. Sn., and 28 per cent. Zn. would be replaced by 70 per cent. Cu., 29 per cent. Zn., and 1 per cent. of the new alloy. As the material is already extensively used in the U.S.A., it should be worth the while of British founders to investigate. We hope in the near future to be able to give our readers more details of the chemical composition of the alloy, so that the more scientific foundrymen will be able to regulate its use without reference to the sellers. In this way the new alloy will have a better chance of finding a larger scope of utility. The British selling rights are in the hands of Mr. Charles Hall, 409, Newton Avenue, Milwaukee, Wisconsin, U.S.A.

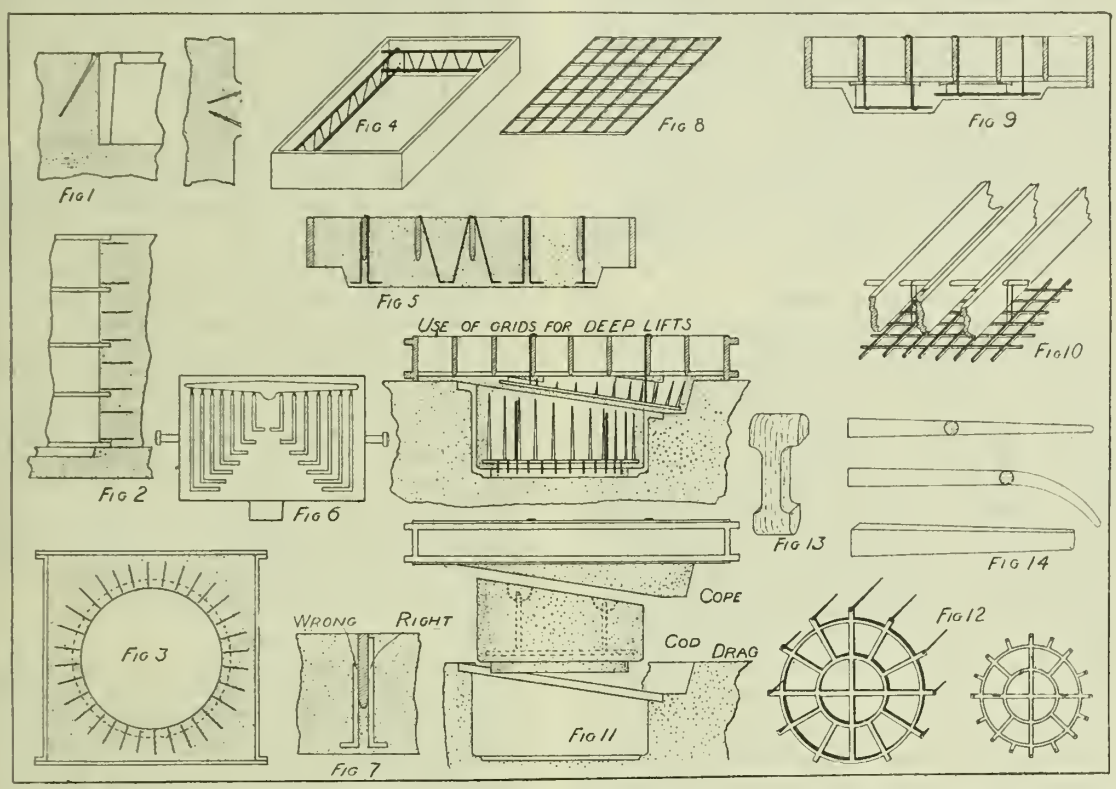
* Paper read at the Autumn Meeting of the Institute of Metals.

An Apprenticeship Course in Foundry Practice.—XI.

By Ben Shaw and James Edgar.

RODDING AND THE USE OF GRIDS.

Sand moulds frequently require to be strengthened to enable them to maintain their shape and position before the rush and pressure of the metal, or to prevent them from collapsing under their own weight, or owing to a combination of these factors. While box bars fulfil this need to a considerable extent, it is not customary to make special boxes for a specific job unless the number of castings required is considerable when it becomes an economical proposition. It follows, therefore, that some arrangement must be made whereby available moulding boxes can be used for a variety of moulds within their capacity. Box bars can only be cast with boxes to accommodate the general run of work for which the box is to be used and when any part of the mould required to be moved with the box is not sufficiently supported by the bars other means must be employed. Deeper boxes can be used to cover a larger area than shallow boxes without the aid of bars, but it must only to support corners or projecting details, but in flat surfaces over which the metal is required to flow in order to prevent the action of the metal washing the surface sand out of position. These sprigs are just ordinary cut nails, either with or without heads, and they vary in length for general work from 2½ in. to 4½ in. They are distinct from what are known as steel moulders' nails, which are required to be cast with the metal, the latter having a bright finish. Although sprigs are especially useful in connection with green sand moulding, because the sand is comparatively weak, they are also effectively employed in dry sand and loam moulding. In green sand moulding they are often introduced during the process of ramming, but for strengthening the corners at joints or other places where the ramming is likely to displace them they are pushed into the sand when the ramming has been completed and before or after the pattern is withdrawn, as circumstances permit. It is important to use the sprigs in such a manner



be remembered that the mould must not only sustain its own weight, but it must be sufficiently strong to resist the pressure of metal. This fact is somewhat overlooked, especially with copes, and while the sand supports itself, the upward pressure tends to lift the sand, even although the box part may be secured. The tendency to lift is somewhat safeguarded by resting weights over the top edge of the box. Unless for small work, it is certainly safer for the boxes to carry bars, and other methods of strengthening moulds made in boxes which are dealt with in this article are simply expedients, and supplementary to the bars. There are times when bars are not possible, and yet support must be given to the sand, but, as a rule, additional strength is given in conjunction with box bars, and in a general sense this is known as rodding.

Sprigs.

The simplest form of support given to parts of a mould involves the use of sprigs. They are employed to strengthen sharp corners, particularly if the corners are likely to be in the path of the direct flow of the metal, and isolated projecting bodies of sand, which have little strength in themselves to resist the pressure of the metal, should also be carefully sprigged. There is very special need for the use of sprigs in moulds for steel, not that they will bind the weak part to the main body of the mould. Thus in strengthening corners sprigs should be set at an angle as shown in Fig. 1.

Rodding.

The term rodding, used in connection with a mould, implies that greater support is necessary than would be supplied by sprigs, although the principle is the same, and the use of sprigs is only another form of rodding. Rodding consists in introducing pieces of wrought or cast iron into the sand during the process of ramming, and in such a way that they support the mould. Any old pieces of iron from ⅜ in. to ¾ in. round or square will answer the purpose, and to increase their value in sustaining the mould they are dipped in clay wash, so that the sand will adhere to them. They are used particularly for overhanging parts of the mould in order to reinforce the sand. Thus ribs, flanges or other projections from the sides of a mould, the patterns for which are drawn in after the main body has been removed, leaving the sand forming the top impression partly suspended, need to be rodded. Fig. 2 shows this form of reinforcement. Pieces of iron are introduced for support even when the shape of the sides of the mould is continuous, and not broken by other impressions. The necessity for their use in such instances occurs in deep moulds when a consider-

able body of sand is present between the box side and the mould, and when there would otherwise be possibility of the sand giving way under its own weight, thus causing it to slip into the mould. Fig. 3 shows the method of their use in deep cylindrical moulds, pieces of iron from 9 in. to 12 in. long being bedded into the sand about 4 in. or 5 in. apart, in layers radiating towards the centre of the job. There should be 9 in. or 10 in. between the layers until the full height of the mould has been rammed.

Another form of rodding is necessary to give support to the sand forming middle parts. In some instances it is better for the box part to have short parts projecting from the sides, but not infrequently middle parts, merely consist of a plain frame, and the amount of sand to be carried may be such as to need support. It is only necessary to give lifting strength to the sand as it comes between the drag and cope and strength to sustain its shape before the pressure of the metal is not needed. Obviously the same form of rodding illustrated in Fig. 3 would be useless for middle parts which are to be lifted, unless the sand is also supported with bars, because, without bars, the rods not being secured to the box, would merely add to the weight of sand and the mould would be more likely to collapse. It is therefore necessary either to rest the rodding on the internal ledge of the box part, as shown in Fig. 4, or, if the box side is straight, to wedge it between the sides. Pieces of iron fixed between the sides of the box may be wired together and claywashed. A middle part does not need much supporting, as a rule, because much of the sand is removed from the centre, and if the inside of the box is claywashed, or only swabbed with water, it assists the sand to adhere more firmly to the box sides, and by so doing possibly dispenses with rodding.

Lifters or Gaggers.

When pieces of iron are introduced in a mould to be used to support projecting parts of the mould which are to be lifted with the box they are known as lifters or gaggers, and the process of introducing them is termed liftering. In principle it is really another form of rodding, but since their use has to do with the lifting strength of the mould more particularly, the term lifters is very appropriate. Lifters therefore concern the cope more than any other part of the mould, though the expression may be applied to the rodding of a middle part. As has been previously stated the drag usually embraces the major portion of the mould, the cope being a cover to take the top impression, and the cope box is made accordingly with straight bars. Very often, owing to some projection required on the top of the casting, or due to the fact that it is necessary to make a joint of the mould below the upper surface of the pattern, the joint of the mould is lower than the joint of the moulding box, and in consequence it is necessary to carry additional sand with the cope. It is with the supporting of this lifting sand that lifters are primarily concerned. In special instances they may also be used when the cover is comparatively flat and flush with the joint of the box. Thus, in some moulds, the top is liable to be drawn by the heat of the metal unless it is well rammed and supported. The cope is likely to draw when it is under the direct influence of the heat of the metal during the whole time of casting a large job and when the surface involved is considerable. The heat may cause parts of the cope to fall on the metal owing to the surface becoming dried, if it is a green-sand mould, to a certain depth, or due to the sand not being sufficiently strong or not rammed sufficiently hard in a dry-sand mould, but it may also be due to insufficient liftering. If the moulding sand has an excess of lime in its composition even liftering very closely will not prevent a draw of the cope under such conditions. Then, with large runners passing through the cope, when the face is unsupported by the drag, the pressure of the flow of metal is likely to carry part of the mould with it, or, in the case of risers, the force by which air and gases pass through may remove parts of the mould unless the sand is strengthened. In the main, however, lifters are employed, as the name implies, for giving that support to sand which will render it capable of being lifted.

In the non-ferrous and steel foundries lifters are usually of wrought iron, and this material is also used to a considerable extent in iron foundries, but cast-iron lifters are also employed. Wrought-iron lifters are readily bent to suit varying surfaces, and any old piece of iron about $\frac{3}{8}$ in. to $\frac{5}{8}$ in., either round or square, will work in for the purpose, providing it is long enough. The shape of these lifters vary, some possessing a single projection or toe, while others have the projections on each side. In some instances it may be necessary to hook the lifters on box bars, but they should only be used when the ordinary type would not have a firm enough hold in the sand. Projecting lifters are likely to be caught when closing the mould, and the jerk given to it may disturb the sand about the other end. Double lifters are sometimes used, being carried over the box bars, but not as a general rule. A number of different kinds used is shown in Fig. 5.

Cast-iron lifters are generally cast in a permanent mould revolving on trunnions and supported on standards. These permanent moulds are of cast iron, usually double sided, and after the metal has been cast into the moulds on one side it is turned over, which brings it into contact with a stopper, and the chilled castings drop out. At the same time the inverted side of the mould can be cast. Many lifters can be cast in a comparatively short time, and the sizes vary. Cast-iron lifters are more rigid than wrought iron, and they are more easily broken to a convenient length if too long. An illustration of a form of permanent mould is shown in Fig. 6.

When introducing lifters it is important to remember that when they are to be used for carrying part of the mould projecting from the box part they should be as long as possible without actually being beyond the top of the box. Many moulders use lifters haphazardly, and, in many cases they do more harm than good, owing to the slight hold they have in the main body of the cope. They are more effectual against bars, and they should be set vertically, although the toe can be set to suit the work. Fig. 7 illustrates the use of cast-iron lifters, right and wrong method. Additional short wood bars are sometimes introduced between existing cast-iron bars, and these can be made as deep as is desirable for the lift to be made. These small bars, which are sometimes referred to as "soldiers," should be used in conjunction with lifters, when it is possible and a deep lift is required to be made. The toe of the lifter should not be less than $\frac{1}{2}$ in. from the face of the mould to prevent the casting being marked.

Grids.

When very deep lifts are to be made, and, in the opinion of the moulder, lifters would either be insufficient or too many would be required, cast grids may be used, as in Fig. 8. Some moulders prefer this form of support for large work when a considerable lift must be made in the cope, but their special value is in supporting bodies of sand which are not carried in boxes, as, for instance, cores or loose parts of the mould, which must be lifted separately in order to withdraw the pattern or to introduce cores. It is, however, their particular usefulness in giving support to green or dry sand moulds that this article refers to. When ordinary lifters depend upon the bars and the sand rammed between them to give them sufficient support so that they may lift the projecting part of the mould, grids are suspended by hangers or S hooks, or when staples are cast in them, they may be suspended on iron bars resting on the top of the box, but invariably packing is wedged between the grids and the bottom of the box bars so that they will remain rigid when the box is lifted and turned over.

Sometimes gaggers or prods are cast to grids when the lift is of an exceptional character, or bits of wrought iron may be cast in the grid, but, as a rule, the ordinary flat grid is more frequently employed. For ordinary lifts in the cope, which would involve a large number of lifters suspended from the box bars, any flat pieces of grid may be employed to cover the area to be lifted, and hooks used to suspend them from the bars. If one grid can be obtained to cover the area it is better, because the number of hooks projecting beyond the cope is reduced. These hooks, however, are not a source of danger, as are suspended lifters,

because the grids are generally packed and wedged —or they ought to be—when the distance from the bottom of the box bars and pattern is considerable. An illustration showing the method of securing these grids is indicated by Fig. 9. When there are facilities for using staples in the grids it is an advantage to leave the top of the cope quite clear. Loose box-bars frequently have holes cast in them in order that lifters may be kept below the surface and iron bars can be passed through these holes, on which are suspended stapled grids, as shown in Fig. 10. These, too, need to be packed and wedged. Grids are exceptionally useful when the full lift to be made would be too great for a single lift with the cope such as is illustrated in Fig. 11. In this instance the core is made in the mould, and because of its depth and the difficulty of obtaining a clean lift with the cope, it is advisable to lift it as a separate piece after the cope has been removed, and it is necessary to introduce a grid to which the sand will adhere to facilitate lifting. Even without the central part of the mould there is quite a good lift to be made with the cope, and a grid is very helpful. In both cases gaggers can profitably be cast with the grids in order that support may be given to the sand over the full depth of the lift. Staples should be cast in the grid for the loose part or cod, to give it its recognised term, and they should be of such a length that when the grid is located they are just below the cope joint in order that they will be easy of access for lifting.

Sometimes pieces of wrought iron are cast in grids instead of cast-iron gaggers, or they may be used in conjunction with cast gaggers, as in the grid for the rod in Fig. 11. The sketch, Fig. 12, shows the two grids used in Fig. 11. It is important to keep the grid well clear of the face of the mould, particularly when the metal to be cast contracts considerably, otherwise the resistance it offers may be such as to cause the casting to crack. Wrought-iron gaggers are frequently helpful in parts of a grid, subject to strain from contracting metal, because they yield to the strain.

Grids are made in open sand and on a level bed by means of stamps and gagger sticks. The shape of the grid is first marked out on the level bed, and the impression made with a wood stamp. There are a few different forms of stamps, and one which is in common use is shown in Fig. 13. Gagger sticks are sometimes of wood, though usually they are wrought iron, either about 1 in. dia. or 1¼ by ½ in. rectangular, and tapered as shown in Fig. 14. They may be bent to form the impression for curved gaggers, and the length of gagger desired is marked on the sticks, which are pressed into the grid impression, at intervals of about 4 in., depending upon the needs of the grid being made. Staples are introduced in the most convenient position for maintaining equilibrium, if used for a rod, and having the ends splayed, and projecting into the grid impression so that the metal will surround and fuse them. They may be pushed into the sand, leaving only the ends visible, or they may be supported in a vertical direction above the mould by means of bricks, according to the direction the staples are required to be, relative to the gaggers.

Chelsea Polytechnic.

The Michaelmas term of this college opened on September 25. We note with pleasure that foundry evening classes are to be arranged, but no definite time is fixed. Whilst not presuming to interfere with the organisation of the school, we feel that it would be appreciated by London foundrymen if Thursday was not chosen, as it is on this night that the local branches of the Institution of British Foundrymen and the Institute of Metals meet. The metallurgical department is controlled by Mr. J. B. Coleman, A.R.C.Sc (head of department) and Mr. W. A. Naish, A.R.S.M., M.I.Brit.F. The fees are very reasonable, being 20s. for one evening per week and 10s. for each additional evening. The school is very centrally situated at Manresa Road, S.W.3, and is served by the District Railway, tramway service No. 34, and eight omnibus routes.

Making Steel without Pig-Iron.

In support of the assertion that it is possible to produce by an "all-scrap" process steel of high quality in the basic open-hearth furnace and at a low cost, Mr. Edwin F. Cone in a recent article* records the fact that at a leading American steel-making plant—that of the Central Iron and Steel Company, at Harrisburg, Pa.—plate steel has been made in marketable quantities for the past four years without the use of any pig-iron. Indeed, since the latter period of the war the Company's three blast furnaces have been idle while the steel plant has been in active operation.

In describing the method adopted the author indicates that it differs from those practised at other plants where departures have been made from the usual pig and scrap process. The process adopted at Harrisburg is the subject of a patent granted to Mr. Robert H. Irons and assigned to the Company, and its distinguishing feature is the maintenance of a high residual manganese throughout the period of the heat. The presence of certain quantities of manganese during the melting-down period now characterises the operation both in acid and basic open-hearth steel-making at many plants, and the practice at Harrisburg may be considered as the development of this feature to its largest possibilities. Two well-known features of open-hearth practice are prominent in the patent:—(1) The use of carbonaceous matter to reduce the charge of pig-iron; (2) the use of manganese-bearing materials, thereby bringing about the elimination of sulphur as manganese sulphide, and securing the advantage of tapping with a high residual manganese. To secure this residual manganese, high-grade manganese ore from Brazil is used regularly as a part of each charge. About 2 to 2½ tons is ordinarily used in a 90-ton heat. The reduced manganese from the ore is alloyed with the steel, the slag being at the same time brought to the point of saturation with manganese. The desired manganese in the bath is thus obtained, and at the time when the heat is ready for tapping the amount of residual manganese is fairly constant at 0.15 to 0.30 per cent. To prevent the steel from losing any of this residual manganese because of insufficient oxide of manganese in the slag, the capacity of the slag in lime and oxide of iron is increased which, combined with the manganese oxide acting as a base, exerts the desired effect on the manganese of the bath. The *rôle* of this residual manganese is two-fold:—(1) Its presence during the whole refining operation prevents any oxidation of the iron in the bath; (2) it is an important factor in eliminating sulphur.

Aside from the manganese ore and the regular and necessary amount of lime, the charge is made up of scrap steel and scrap iron in proportions varying from 60 to 90 per cent. of the former and from 40 down to 10 per cent. of the latter, largely heavy melting grades. The regulation of the mixture depends on market conditions and requires a constant study of the price and availability of the scrap brought in from outside. The flexibility of the charge is its feature, it being possible to make a heat with 90 per cent. steel scrap or up to 40 per cent. scrap iron, with no variation in quality.

Another factor in the charge is carbon in the form of coal, coke, or charcoal, the amount depending on conditions. An interesting feature at the plant in question is the use of river coal, really "buckwheat" anthracite. Tons of this are being taken daily from the Susquehanna River, which runs alongside the plant. The coal is carefully washed, dried, and screened and used in each charge in varying proportions with the scrap and other materials. It furnishes carbon and plays other lesser *rôles* in the refining process. The same coal at present is fired under boilers to raise the steam used in the plant.

The purifying effect of the residual manganese, which is the key to the success of this unique "scrap and carbon" process, is not a new principle, but the method of its application is.

* "The Iron Age," September 7

A Study of the Weight of Iron Castings.*

By John D. Wise, Urbana, Ill.

It might appear superficially that all castings made in the same manner from the same pattern must necessarily be of the same weight, but observation of the weights of various castings made from the same pattern under identical conditions has disclosed surprising variations. The purchaser of castings makes a peculiar concession to the foundryman. In his dealings with all other persons from whom he buys, he is guided by the principle that he must know in advance the amount of the invoice which will be rendered. To the foundryman, however, he gives a more or less *carte blanche* for a number of castings the weights of which generally do not correspond with those of previous shipments. The purchaser of castings realises that the casting of minimum weight which he accepts serves its purpose as well or better than those of greater weight. Frequently the machine shop purchases the casting and in this way has the direct interest in excess weight referred to above. Three other considerations enter into its problem in dealing with the overweight casting. First and most important is the removal of the surplus metal which is present on the surfaces to be finished. This frequently assumes dangerous proportions. For instance, it is not uncommon to find $\frac{3}{4}$ in. of stock where $\frac{1}{4}$ in. would be sufficient to eliminate the skin of the metal and to escape minor surface defects. The relative amount of metal occurring on finish pads and on portions where machining is not necessary will be covered later.

① Casting Number	② Casting Name	③ Weight when hand molded	④ Weight when Mach. molded	⑤ Reduction-% ③-④ / ③×100	⑥ Saving per cst in lbs ③-④	⑦ No Req'd	⑧ Rate per lb ¢	⑨ Total $ Saved ⑥×⑦×⑧
C-5R	Truck	38.6	33.3	13.7	5.3	220	6½	75.79
D-6	Base	340	312	8.2	28	15	6½	27.30
C-42A	Draw cyl cover	49.6	45	9.3	4.6	10	6½	2.87
B-74	Sand guard	24	23	4.1	1	20	6½	1.25
C-77	Squaring shaft	65	58.	10.7	7	10	9	6.30
D-78	Frame	340	300	11.7	40	10	9	36.00
D 79A	Leveling table	121	112	7.4	9	10	9	8.10
D-80A	Base	264	200	24.2	64	35	6½	145.60
C-201A	R.O.Bracket	50	38.	24.	12	5	9	5.40
C 202A	" "	58	38.	34.5	20.	5	9	9.00
C-227	Sand guard cover	123.	110	10.6	13.	1	6½	.81
B-308	Safety st collar	25	1.85	30	.65	45	6½	1.90
B-310	Insp. hole cover.	6.2	5.5	11.3	7	10	6½	.44
B-430	Leveling levers	4.3	4.	7.	3	30	9	.81
B-431	" "	5.3	3.3	37.7	2.	30	9	5.40
B-549	Cylinder Head	79.	60	24	19	15	6½	17.81
A 1500	Muffler section	3.4	3.	11.7	.4	100	7	2.80
C-1500	" "	3.6	3.2	11.1	4	150	7	4.20
C-2541	Wheel	38	37.4	1.5	.6	100	6½	3.90
A-2599	Base	324	311.	4.	13	10	9	1.70
B-2638	Crank hub	41	4.1	0	0			
C-2651	" disc	12.4	9.6	22.6	2.8	20	9	5.04
C-2768	Bracket	2	1.3	35.	7	40	9	2.52
B-3360	Cylinder head	55	54.8	.36	.2	10	6½	.12
A-5018	Jolt table	268	249	7.1	19	10	6½	12.35
A-5732	Draw pistan	116	113	2.6	3	1	6½	.19
A-5872	Base top cover	12.	11	8.3	1	20	6½	1.30
A-7591	Muffler	2.	1.8	10.	.2	40	7	.56
A-7745	Car frame	71	56	21.2	15.	20	6½	19.50
B 7745	" "	66	54.	18.2	12.	20	6½	15.60
A-7864	Base	282	225	20.2	57	60	6½	222.30
A-7879	Shield	33	29	12.1	4	60	6½	15.60
A 7883	Wheel	27.2	24.3	10.6	2.9	500	6½	94.25
A-7982	Pressure hd stop	12.3	12.	2.4	.3	35	6½	.68
A 8331	R.O Trunion	66	64.	3	2	20	6½	2.50
B-8331	" "	68.8	63.3	8	5.5	20	6½	6.87
A-8405	Jolt piston	527	475	9.9	52	10	6½	32.50
A-8415	Housing bushing	248	246.	8	2	10	6½	1.25
A-8792	Jolt piston	330	316.	4.2	14	15	6½	13.12
D-8929	Leveling car	516	480	6.6	36	15	6½	33.75
C-8931	Draw cylinder	722	535	26	187	15	6½	175.31
C-8934	Housing bushing	422	415	16	7	15	6½	6.56
TOTALS		5802.3	5137.75		664.55	1787		
AVERAGES		138.1	122.3	10.8	15.8	42.5		
TOTAL SAVING								$1029.25

FIG. 1.—TABLE SHOWING COMPARATIVE WEIGHTS OF CASTINGS.

Handling Problem is Affected.

In most cases the addition of 10 per cent. to the weight of a given casting will not change it from a hand-lifted weight to a crane-requiring weight or from one crane to another of larger capacity, but this will happen in a certain per cent. of the cases and is, of course, an avoidable loss. The human factor enters here also, since the work of handling castings by hand is materially lessened when the weight of the castings handled is decreased an average of 5 to 10 per cent. Of course, such a decrease in weight reduces fatigue and increases efficiency.

Another concern of the machine shop in connection with overweight castings is in the use of jigs or fixtures. Since overweight takes the form of excess metal on the outside of the casting it follows that this excess metal interferes with jigs and fixtures, causing either a loss of time for adjustment or rejection of the casting. The rapidly increasing use of jigs makes this factor one of prime importance.

Foundrymen should be deeply interested in the standardisation of weights of castings and in the reduction of standardised weight to a minimum. By decreasing the weight of all the castings produced from one pattern to the minimum weight necessary to meet specifications, the foundryman will decrease the amount of money which he receives, since his invoice is rendered on a per pound basis. This result might appear to be to his disadvantage and cannot be explained away by assuming that the decreased amount of iron melted and handled will show a saving that will offset the loss of the revenue from the excess weight. The real solution for the foundryman consists in a moral interpretation of his duties toward his customers—a policy or rendering the maximum service for each shilling charged. He constantly should endeavour to keep the weight of the casting down to the minimum.

Ultimately the foundryman who seeks to build up his business on the principle of furnishing minimum-weight castings will outdistance competitors who cannot render the same service. Also he will be able to meet the competition of the manufacturers of forgings and pressed steel parts, both of whom may be able to replace a casting by a member of less weight and greater uniformity and frequently at a less cost per piece. This competition presents a definite challenge to the foundry industry to meet the quality as well as the price of these products.

Fig. 1 presents the result of a comparison of the weights of castings made from the same pattern or from patterns slightly altered to reduce the weight, maintaining in every case, however, the same requirements for the finished castings. Each horizontal line contains a record of the castings made from one pattern when hand moulded and later when machine moulded. The weights given in columns 3 and 4 are average weights of a number of castings. Column 5 shows the weight reduction in per cent.; columns 6, 7, 8 and 9 show the weight reduction in pounds per casting, the number required, the price per pound, and lastly, the value of the saving for the quantity considered. The average weight reduction of 10.8 per cent. indicates that a study of the reasons for the saving will produce important results since the saving is large enough to be of considerable importance. In considering the problem of weight reduction it will be convenient to set forth the successive steps in the making of a mould, assuming ordinary side floor work of moderate size. Beginning with the blueprint the steps in the making of a casting are as follows:—(1) The amount of finish metal to be allowed; (2) method of moulding; (3) decide on the amount of draft; (4) make the pattern; (5) ram the mould; (6) rap the pattern; (7) draw the pattern; (8) sleek the mould; (9) patch the mould; and (10) close and pour.

Patternmaker Determines Allowances.

It will be noticed that the first three of the most important steps leading to the producing of a casting from a blueprint are performed in the pattern shop before the pattern is made. In

* A Paper read before the American Foundrymen's Association

too many cases the patternmaker decides these important factors without conferring with the foundry and machine departments. In so doing he influences to a large degree the subsequent methods these departments must employ and to a large degree the amount of unnecessary work to which they may be subjected. Obviously a more logical plan should be adopted at the start and carried throughout all the operations occurring between the blueprint and the finished casting. No single operation should be considered as a separate unit, but each should be considered as a part of one logical plan.

The first factor, *deciding upon the amount of finish metal necessary,* is usually settled by the patternmaker in accordance with the following general rule: "It is always possible to machine off surplus metal while none can be added." He thus adds a "safe" amount of metal in order to allow for the unpredictable "come and go" of the casting. If it were known that the castings would be uniform in size it then would be possible to allow only enough finish metal to require the removal of the skin and its attendant surface imperfections. But all foundrymen are familiar with the fact that hand moulding cannot produce this uniformity. Happily, most of them are also aware of the fact that machine-moulded castings possess uniformity of size and weight. It is a matter of general experience in the automotive and other industries that machine moulding produces castings of uniform size and without excess metal for the machine shop to remove.

The second factor, *deciding upon the method of moulding,* consists chiefly in the location of the parting line which seriously affects the production of the casting, but does not usually exert any effect on the weight.

Unnecessary Draft.

The third factor, *deciding upon the amount of draft necessary,* affects the weight to a large degree. Again the patternmaker generally decides this question without conferring with the foundryman who must use the pattern. He works on the principle that "too much draft will not harm the pattern while too little will cause excessive breaking of the mould and will cause the pattern to be returned for alterations." He therefore allows liberal draft, a part of which is necessary and a part of which is superfluous. This excessive draft adds a constant and unnecessary weight of metal to the finished casting. Draft is necessarily primarily in hand moulding since it is impossible to draw the pattern straight upward from the sand by hand. Theoretically a pattern drawn vertically need have no draft. This action is closely approximated by moulding machines which are much more accurate than a human hand can be.

The fourth factor, *making the pattern,* has far-reaching and interesting effects upon many other problems having to do with the cost of the casting but not on the item of weight. When the pattern is received in the foundry, the first operation performed is the *ramming the sand around it.* This introduces variable elements which greatly affect the weight. The ideal condition desired in ramming is that the sand shall be of the maximum density and yet allow proper venting; and second, that it shall be of exactly uniform density over the entire surface of the pattern. The skilled moulder approaches, only in a rough way, the ideal condition. He obviously cannot produce a mould of exactly even density and the result invariably follows that the equal liquid pressure of the mould forces back the sand at the soft portions and produces at these points swells on the casting, all of which are unnecessary and add preventable weight. It also is true that the maximum density of sand is never obtained, for the moulder leaves a large margin of safety to be certain of avoiding trouble due to lack of venting in the sand. Obviously this factor cannot be entirely eliminated but it can be reduced to a negligible quantity. The moulding machine, with its constant uniformity from the beginning to the end of the day and from day to day, can accomplish exact uniformity of the entire surface of the mould and can approach the maximum uniform density much more closely than can the moulder attempting it by hand.

Excessive Rapping.

The sixth factor, *rapping the pattern,* is an operation introduced by the moulder for the purpose of enlarging the mould in order that the pattern may be withdrawn from the least possible amount of damage to the sand. Rapping accomplishes this purpose, but it also enlarges the cavity so that overweight is introduced into the casting. When considering the weight of the casting with a view of reducing it to a minimum, it is readily apparent that if rapping is eliminated entirely the reduction in weight sought for will be obtained. By omitting rapping, however, the moulder would invariably make matters worse by introducing excessive patching of the mould. Therefore he is forced to choose rapping as the lesser of the two evils. Again, the moulding machine is suitable for accomplishing that which is impossible to the moulder working by hand. It will draw the pattern vertically upward from the mould, loosening it from the clinging action of the sand by means of air or electrically operated vibrator which does not appreciably enlarge the cavity. In this way the rapping of the pattern can be eliminated with a resultant saving in weight.

The eighth and ninth factors, *sleeking* and *patching the mould,* are in reality repair operations to overcome the damage done to the mould by the withdrawal of the pattern. Both of these operations should be eliminated, but this is not possible when the pattern is drawn by hand. Moulding machines draw the pattern so accurately that no sleeking and patching are necessary.

The tenth factor, *closing and pouring the mould,* introduces little or no variation in the weight, unless the density of the iron is affected slightly by the height of pouring head or by such special methods as the rotation of moulds, while being poured.

By dividing the ten operations outlined into

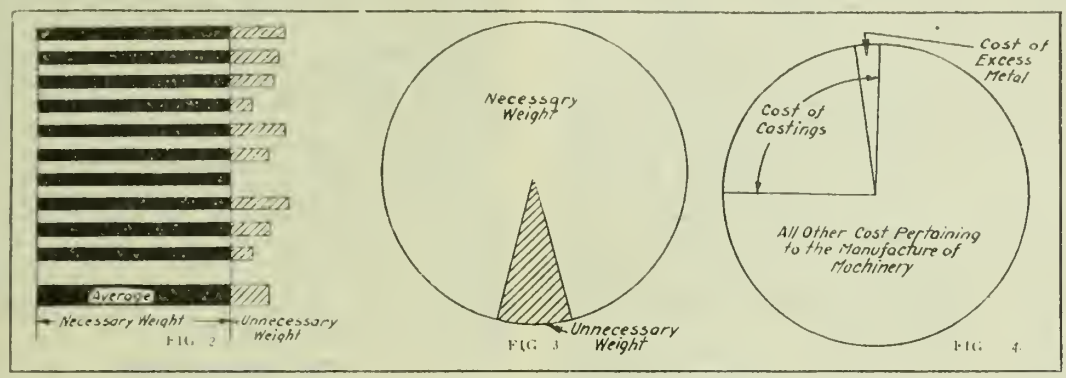


Fig. 2.—Typical Condition Existing in the Case of Castings Made From One Pattern by Hand Moulding.

Fig. 3.—The Average 10.8 Per Cent. Reduction of Weight Shown in Fig. 1 is Represented Here Graphically.

Fig. 4.—The Cost of Excess Metal to the Manufacturer of Machinery is Shown Graphically.

two groups, first, those performed in the pattern shop, and second, those performed in the foundry, it is apparent that the problem is a common one for the foundry, machine shop, and the pattern shop to solve before work on the pattern is started. If each of these departments is to perform its particular portion of the work in the least time and at minimum cost the operation must be planned jointly from beginning to end by those who are responsible for its execution.

Variable and Constant Factors.

To attack more intelligently the general problems of casting overweight the operations causing it may be divided into two classes; First, those causing variable amounts of overweight, and second, those causing constant amounts of overweight.

The operations causing variable excess weight are as follows: (1) Non-uniform ramming of the mould; (2) rapping of the pattern; (3) drawing of the pattern obliquely; and (4) sleeking and patching the mould.

The operations causing constant excess weight are as follows: (1) Too much finish metal; (2) Too much draft.

It is important to know definitely which of these factors adds the most excess weight to the casting so that their relative importance may be ascertained and treated accordingly.

No comprehensive study has been made of the importance of these different operations, and therefore no answer can be definitely given here. Excessive finish allowauce metal exists on the parts which are to be machined and consequently, on a casting which is to be machined all over, this extra metal may take the shape of an extra $\frac{1}{4}$ in., more or less, added to the entire surface of the casting. Its percentage to the total weight varies with the shape of the casting. It would be minimum on a spherical casting and maximum on a thin, flat casting of a large area, such as a piano plate, and reach the maximum on a casting which is machined all over. Excess metal allowed for finish may be the most important factor in overweight or it may be one of the smallest cousiderations, depending entirely upou the shape of the casting.

Excessive draft is similarly variable. It is not necessary to use any draft on a spherical pattern parted on the diameter, aud it follows that such a casting would not carry any extra metal on account of draft. A cubical block would uecessarily have draft on four of its six sides and the excess metal in such a case would be relatively heavy. A casting which is deep in proportiou to its area will have on it a maximum of excess metal due to draft allowance.

Swells on Castings.

Swells on the castings are of two kinds. The first is an enlarging of the entire casting which is caused by the giving of the sand as the liquid pressure of the metal is exerted upon it. This is uniform over the entire surface, and in amount is inversely in proportion to the density of the sand. The secoud class of swells are those which are confiued to a small portion of the casting surface caused by light ramming at that particular point. These may be so slight as to be almost imperceptible in the case of an experienced moulder, and may assume such proportions as to be highly objectionable in the case of unskilled men. However, both are entirely eliminated in machine moulding.

Rapping the pattern is usually performed backward and forward and from right to left but seldom by driving the pattern into the sand. The casting is enlarged, therefore, rather uniformly on the sides but little, if any, on the top and bottom. The amount of enlargement depends upon the amount of rapping and this is determined by several things. A pattern of a shape difficult to draw is usually rapped more than one of easy drawing shape, and an inexperienced moulder finds it necessary to rap more strongly than the experienced moulder. The use of vibrators eliminates excess weight due to rapping.

The sleeking process enlarges the mould uniformly, or approximately so, over the entire surface and affects different shapes of castings in the same manner that excess metal for finishing purposes affects them. The principal point to bear in mind in regard to sleeking is that it is an entirely preventable evil, since by eliminating rapping and by drawing the pattern accurately it is not necessary. Patching is in much the same class as sleeking, except that it is usually local in effect. When building up a broken portion of the mould the moulder naturally puts extra metal on the casting rather than not leaving enough.

Fig. 1 presents the data gathered when 42 light machinery patterns were changed from hand to machine moulding. Fig. 2 shows the typical condition existing in the case of the castings made from one pattern when hand moulded. The outstanding feature is the erratic variation. For the 42 different cases considered in Fig. 1 the average reduction is 10.8 per cent. in weight. This is shown graphically in Fig. 3. The effects of this reduction are far reaching. Castings are purchased by weight; therefore the cost of rough castings is decreased 10.8 per cent. to the user.

Since the cost of castings is about 20 to 30 per cent. of the gross cost of light machinery this means a saving of 2 to 3 per cent. which is added directly to the profit of the manufacturer, as indicated in Fig. 4.

Nor is this all. Following the casting into the machine shop there are several items that will result in distinct savings. (1) There is less metal to be machined off; (2) there is less layout work; (3) castings may be handled more rapidly in jigs; and (4) there is less filing to be done on the rough surfaces.

No investigation has been made of the amount of saving effected by these changes in the machine shop, but, whatever their magnitude, they decrease the cost of the finished casting and are a step in the right direction.

At present there is evidence of a tendency for castings to be replaced by pressed steel parts. Savings can be effected in the total number of hours of labour expended on a casting, in the amount of overhead burden borne by the casting, and in the amount of material used. Moreover, a saving of 10.8 per cent. in weight is possible and highly desirable.

Reducing Hematite to Magnetite with Methane.—During recent experiments on the reduction of iron ores with fuel gases carried out at the Pacific Experiment Station of the U.S. Bureau of Mines, it was noticed that at temperatures up to 800 deg. C. the methane in these gases was practically inert as compared with hydrogen or carbon monoxide. A number of experiments were then carried out with mixtures of methane and hydrogen over a wide range of temperatures to find out when the methane would begin to function actively as a reducing agent. While it reacted slowly at all temperatures tested, its reaction in the reduction of hematite to magnetite, the first stage in the reduction of iron, did not become sufficiently rapid to be of industrial importance until temperatures of over 900 deg. C. were used. A rough approximation of the velocity constant of this reaction was made for all the temperatures at which tests were made in order to obtain some unit figures of value in designing industrial apparatus for carrying out this reaction. The details of these experiments are contained in Serial 2,382, published by the Bureau.

Spanish Iron and Steel Industry Developments.—During the war Spain made great efforts to become independent of foreign countries by completing or installing important iron and steel plants. Among these may be mentioned the works at Reinosa (Santander) erected by the Sociedad Española de Construccion Naval, whose shipyards at Cartagena, Cadiz, Ferrol and Sestao (Bilbao) will form important consumers for the products of the Reinosa works. The Construccion Naval has secured an order for six electric locos. The Sociedad Duro-Felguera (Oviedo) intends to increase its production to 60,000 tons of steel yearly, and is electrifying its rolling mills. The Altos Hornos de Bilbao have continued to improve their plants. A syndicate of Bilbao has erected at Sagunto (Valencia) blast furnaces which will be able to supply 300,000 tons of pig-iron yearly. In 1918 Spain consumed 450,000 tons of home-made pig-iron and about 38,000 tons imported. Imports revived after the war, but the Spanish iron and steel makers are endeavouring to check them by means of the development of their own plants and the new Customs tariff.

White Metals.*

By A. H. Mundey, C. C. Bissett and J. Cartland.

The family of white metals is a very large one, and although a great deal of investigatory work has been carried out in connection with it, the amount of attention it has received, compared with that accorded to the alloys of which copper is the chief constituent, is very small. Probably it is for this reason that the manufacture of white metals, particularly of those chiefly composed of tin, antimony, and lead, has been regarded as a business with many so-called trade secrets. This latter condition no longer obtains, as it is obvious that the only secret is that which is the result of patient investigation, and the exercise of the highest skill and experience available.

For practical purposes alloys which are generally described as white metals may be classified into (1) anti-friction or bearing metals, and (2) other qualities, such as solders, die-casting metals, etc.

The exact physical properties required in a lining for a bearing are not finally agreed upon. It is generally admitted that in the ideal journal the shaft never comes in contact with the bearing at all, the metallic surfaces being completely separated by a film of oil. This condition would at first sight appear to render the particular material of the bearing a matter of small importance, but the material itself plays an important part in the maintenance of the oil film.

Engineers demand a certain balance of properties in a bearing. It must be sufficiently hard and strong to resist distortion under working loads and irregular stresses. It must present a fine surface, not liable to rapid abrasion, and on the other hand must have a measure of plasticity which will permit it to accommodate itself to slight want of alignment of shafting; finally, it must be sufficiently tough to resist fracture under shock. Experience supports the opinion that a homogeneous metal is not suitable for a bearing, that neither a single metal nor an alloy which is a solid solution can be employed with success, and that either a metal consisting of a soft matrix with hard crystals embedded in it, or a hard metal interspersed with veins of a softer constituent, has the necessary surface for a practical bearing alloy. The best service is obtained from an alloy which, though wanting in homogeneity, has its undissolved constituents distributed in a regular and uniform manner. The authors are of opinion that this mottled surface, in which the harder portions are in slight relief, provides a number of pools and canals which serve to retain the oil film, and, on account of their fine and even distribution, promote the spreading of the oil over the surface by a function which is closely related to capillarity.

The usual tests for tensile strength, hardness, and compression have been made on representative alloys. They are shown in Table I. The test-pieces were prepared by casting into a cast-iron stick mould under uniform conditions. The temperature of casting was about 350 deg. C., the mould being heated to about 100 deg. C. The acting portion of the test-piece was 0.564 in. in diameter, the length being 2 in., according to the usual formula. The Brinell tests were all taken with a 10-mm. ball at a uniform load of 500 kg. The compression tests were made by taking cylinders 0.564 in. dia. × 0.5 in. high. The first observation was made when a permanent deformation of 0.001 in. was produced, the ultimate figures when the test-piece was compressed to one-half its original height.

The choice of a bearing metal is often controlled by consideration of first cost. Tin being the most expensive constituent of the usual white bearing metals, the proportion of tin mainly affects the price. For the highest-powered engine bearings for automobile, aero, and similar services, the nine alloys whose compositions are given in Table II. may be looked upon as good representative types.

No. 1 alloy, which is quite free from lead, combines maximum toughness with strength. This metal was mostly favoured in aero-engines throughout the war, and gave generally excellent results. It is probably ideal for big-end bearings.

No. 2 is also a lead-free alloy, harder than No. 1, owing to the presence of a higher percentage of antimony. It has, however, a useful degree of toughness, and is very useful for general work for main bearings. The presence of a small quantity of lead in this alloy is of no great detriment if the even distribution of the constituents, which has been already emphasised, is insisted upon.

Table I.—*Mechanical Tests of Bearing Metals.*

Alloy No. (See Table II.)	Tensile test. Tons per sq. in.	Elongn. per cent. on 2 in.	Brinell No. 10 mm. ball 500 kg.	Compression test. Tons per sq. in. Yield point, 0.001 in.	Compressed to ½ length.
1 ..	5.12	11.60	24.9	3.569	14.732
2 ..	6.65	7.10	33.3	4.372	17.232
3 ..	5.60	0.00	34.5	4.284	17.640
4 ..	5.70	0.00	32.1	4.640	17.500
5 ..	5.04	0.00	27.1	3.696	12.856
6 ..	4.58	0.00	21.8	3.660	11.284
7 ..	5.48	0.00	31.3	4.016	12.212
8 ..	6.36	0.00	37.0	4.550	17.856
9 ..	4.69	2.80	24.9	3.590	13.356

As regards Alloy No. 3 it will be seen that the lead appears to cause the disappearance of any useful elongation, but the tensile test fails to show all we need in this case, for it is the experience of engineers that this particular alloy is excellent in its resistance to shock.

The so-called Babbitt metals are legion; the following may be regarded as fairly representative. Their real value depends not by any means only upon their actual percentage composition, but upon the care in preparing and melting, ensuring even distribution of the constituents.

Alloy No. 4 is very useful for heavy loads and high speeds: Diesel engines, turbines, rolling mills, locomotives.

Table II.—*Composition of Bearing Metals.*

Alloy No.	Tin.	Antimony.	Copper.	Lead.
	Per cent.	Per cent.	Per cent.	Per cent.
1	93	3.5	3.5	—
2	86	10.5	3.5	—
3	83	10.5	2.5	4
4	80	11.0	3.0	6
5	60	10.0	1.5	28.5
6	40	10.0	1.5	48.5
7	20	15.0	1.5	63.5
8	78	11.0	11.0	—
9	5	15.0	—	80.0

Alloy No. 5 is used for internal-combustion engines of all types, steam-engines, dynamos, locomotives, etc.

No. 6 is a generally useful alloy for heavy pressure and medium speed or medium pressure and high speed; automobile engines, railway and tramway bearings.

No. 7 is also a useful metal for medium pressures and speed, or light pressure and high speed.

The white metal No. 8, commonly called plastic metal, is usually of the approximate composition given in Table II. In some cases a little lead is added. It is used very extensively by millwrights and marine engineers for repair jobs; it is hard and durable, and it is self-tinning. The constitution of this alloy lends itself to its employment in the special manner which has suggested its name. The period of solidification from the moment of the falling-out of the copper-tin constituent to the final freezing of the eutectic is an extended one, and during this period the metal is in a plastic condition; consisting at this time, as it does, of a mixture of crystals and liquid, it will "bind" in much the same way as thawing snow and for a similar reason. It is therefore capable of being spread and fashioned into the form required, somewhat similar to the function of making a

* Abstract of Paper read at the Swansea meeting of the Institute of Metals.

plumber's "wipe-joint." Repairs of an extensive character have been effected at sea and on the field behind the battle-lines with this metal, and the artificer who is working at a distance from his repair depôt or supply base is usually careful to have a small stock of it to hand.

The lead-base bearing metals are fairly represented by that known as magnolia metal (No. 9). This is usually of the composition shown in Table II., with sometimes a small portion of bismuth added. The same general rule obtains for the success of a lead-base anti-friction metal as for the tin-base alloys, the structure consisting of the hard cuboid tin-antimony crystals in a matrix of the tin-antimony-lead eutectic. Just as in the tin-base alloys these tin-antimony cuboid crystals stand up in slight relief *when in use*, and the slightly lower surface of the matrix assists the lubrication. These alloys deserve much more attention than they usually obtain, and in circumstances when the engineer can arrange with his designer to provide rather long bearings, ensuring the distribution of the load over an extended area, excellent results in running and endurance can be obtained.

It will be seen that the action of tin-base and lead-base bearing metals are very similar, the essential difference being that in the former the copper-tin epsilon constituent prevents the segregation of the tin-antimony crystals, and the matrix of tin hardened with copper is tougher than that of the lead-base alloys. Alloys of this character are specially useful in accommodating and rectifying slight want of alignment in the erection of shafting, or in similar conditions. It is worth noting that alloys of this description are being employed very largely at the present moment on continental railways, particularly in Central Europe.

Bearings of this alloy have recently been found to be capable of carrying their load and continuing their duty under increased temperatures to a greater extent than many tin-base bearing metals in similar circumstances. This is in agreement with theoretical considerations, but is by no means the commonly accepted view of engineers.

The employment of barium and calcium, as hardeners of lead for the preparation of bearing metals is a matter of great interest, but its importance from a manufacturer's point of view is considerably less at the present moment than it was during the war, when tin was scarce and correspondingly expensive, and when these alloys promised some relief as substitutes for tin-base alloys. The difficulties attending re-melting, due to the losses of the hardening constituents by oxidation, are very real, the production of excessive dross being a drawback, as the conditions under which metal has to be re-melted for relining bearings on service are frequently very different from those which obtain in a laboratory or in a well-ordered foundry.

Testing of Bearing Metals.

The testing of bearing metals is generally performed by running sets of bearings of the various alloys under service conditions for a certain period (if possible extending to several months) giving them constant attention and subjecting them under observation to conditions as nearly similar to one another as possible, so that the results may be fairly comparable. At the expiration of the period decided upon the bearings are examined, if they have not failed or given actual trouble in the meanwhile. The observed behaviour in running, and also their condition at the end of the trial, indicate their value; but the test is not a scientific one, and though thoroughly useful in showing that a certain alloy will make a satisfactory bearing, it is unsafe to condemn one which may have failed, as in trials of this character abnormal conditions may arise which escape notice.

A Thurston machine designed for oil testing had its bearings replaced by others of exactly similar form in the several alloys to be tested. Trial runs, using these bearings under similar conditions as to pressure, speed, and duration, were made, and figures obtained in (*a*) rise in temperature per 1,000 revolutions, (*b*) coefficient of friction as shown by the tendency to seize and indicated by the swing of the pendulum of the machine. The drawback to these trials consisted in the fact that some alloys were suitable for light loads and fast speeds, whilst others were more efficient for heavy loads and slower running. Actual comparisons are therefore not correct. In all cases the bearings are freely lubricated, usually by pad lubrication.

There is always to be noted the degree of finish of the bearing; this is met by the only reasonable method of boring and scraping the bearing to the highest possible degree of refinement in workmanship. The human element, represented by the skill of the mechanics, cannot be eliminated. Hammer dressing of bearings is a well-established custom, the evident intention being to consolidate the material by cold-working. In reality it has a slight softening effect, and in those alloys in which the hard constituents are closely packed the crystals are seriously crushed, and, by the destruction of their natural orientation, their interlocking is diminished and the alloy is weakened, or in some cases even cracked.

Summary.

(1) The chief value of white bearing metals is due to the way in which they maintain the oil film. This is effected by the hard constituents standing up *in use* in slight relief, the softer matrix thus forming numerous evenly distributed channels, which maintain the oil by capillarity. A single metal, or a metal consisting of a solid solution, will *not* function as a bearing metal.

(2) In the tin-base bearing metal the copper-tin epsilon crystals solidifying out first entangle the cuboid tin-antimony crystals which subsequently form and prevent their segregation, thus ensuring even distribution.

(3) The functions of tin-base and lead-base alloys are similar; the latter could be much more generally used than is the case at present, the chief differences being the action of the copper-tin crystals mentioned in (2) and the fact that the matrix in the tin base is tougher.

(4) The greatest care and skill must be exercised in the handling of bearing metals in practice, otherwise either the hardening constituents will be left in the ladle by liquidation or the metal will be overheated and the structure spoilt.

William Beardmore & Company, Limited, have constructed, and are experimenting with, a six cylinder aerial crude oil engine of a type which develops about 1,000 h.p. The fact that the new engine is being constructed at Parkhead lends significance to Lord Weir's remark at Renfrew Aerodrome recently when he said that he hoped to read within another ten years of an entry for the King's Cup of a "St. Mungo Mark 4" machine with a 2,000 h.p. Parkhead engine.

The Motherwell Wagon & Rolling Stock Company, Limited, have recently been successful in obtaining the undernoted contracts:—North British Railway, 230 pairs wheels and axles; Caledonian Railway, 500 pairs wheels and axles; East Indian Railway, 100 pairs wheels and axles; Rohilkund and Kumaon Railway, 300 pairs wheels and axles; Burma Railways, 200 pairs wheels and axles. They have also to build 250 16-ton mineral wagons for the North British Railway, this being the balance of an order for 487 wagons.

The Turbine Furnace Company, Limited, of 238b, Gray's Inn Road, London, W.C., have lately taken orders for their furnaces from the United Steel Companies, Limited, Treeton, near Rotherham; the Butterley Company, Derby; Bradford Steel Rolling Mills, Birmingham; Fairbairn, Lawson, Combe, Barbour, Limited, Falls Foundry, Belfast; Richard Thomas & Company, Limited, Cwmfelin Tinplate Works, Swansea; the Seaton Delaval Coal Company, Seaton Delaval; and the Hackbridge Cable Company, Hackbridge, Surrey.

American Blast-Furnace Practice.—The rule for rating the capacities of blast furnaces adopted by the Southern Ohio Pig-Iron & Coke Association is based on the burning of a certain amount of a "base" coke in a given time (60 lbs. coke per cub. ft. of working volume in twenty-four hours). Starting with the idea that there is a definite rate of combustibility for a standard coke, assuming that the ore mixture contains 51.50 per cent. iron in the natural state, and arbitrarily using 1,800 lbs. of coke per ton of basic pig-iron when the fixed carbon in the coke is 90 per cent., it is a simple process to determine what any blast furnace should make under varying conditions of coke, ore mixture, and percentage of silicon in the pig-iron.

Contribution to the Discussion on Mr. Smalley's Paper on High Tenacity Brass and Bronze.

Dr. F. Johnson wrote that he wished to congratulate the author on the presentation of a Paper of great interest, and one of far-reaching importance. It represented a combination of high technical skill, scientific knowledge and works experience, backed up by the resources of a big industrial organisation.

Much of the work described in the Paper bore upon problems with which the writer was familiar, and to a great extent some of his own work had been carried out in the same domain.

There was one charge which he would level at the author, which, however, sprang from no lack of appreciation of the splendid services rendered to foundrymen by the author's work, and that was that the Paper almost completely ignored the work which had been done by other investigators. There were, for instance, the researches of Charpy, Lohr, Guillet, Hudson, Professor Turner and his collaborators, and so on, which should, at least, have merited reference. The writer was particularly gratified to observe that Mr. Smalley accepted the constitutional diagram of the copper-zinc series so far as it related to the beta phase as based on the dimorphism of that phase. With this acceptance he (Dr. Johnson) wholly concurred.

With regard to the curves representing the relationships of mechanical properties to compositions, the writer felt that an insufficient number of points had been taken, apart from the fact that the constitutional diagram represented conditions much nearer to equilibrium than the author's alloys could be. But for practical purposes the author's results were invaluable. The writer was particularly interested to note that Mr. Smalley placed the alloy of maximum strength as existing in the all-beta field.

This confirmed the result which the writer had previously obtained, upon which considerable doubt had been cast, but which the author's results now entirely vindicated.

The results obtained by Mr. Smalley and by the writer are given herewith for comparison:—

No. and Composition.	Treatment.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent.
No. 12 from the writer's Inst. of Metals paper. Cu. 53.11 % Zn. 46.8 %	Cast bar annealed at 650° C. for 2 hrs.	10.53	30.4	37.5
From the author's present paper.				
Cu. 53.3 % Zn. 46.7 %	Cast bar as forged	9.0	29.7	24
		9.7	32.8	28
	Forged and annealed at 650° C. for 1 hr.	7.5	29.10	22.5

There were many points of detail in the Paper which presented themselves for discussion. On page 5 the composition of the fourth alloy was given as 46.7/53.3.* This reversed the order in which the components of the other three alloys were given. On page 10 the author stated that he re-annealed his rolled ingots so as to restore them to their original "cast" Brinell hardness number. From experiments on the annealing of chill castings the writer had found that marked differences of hardness were obtained as between small ingots "as cast" and after cold-working and annealing. Had the author experienced the same thing, and did he endeavour to adjust the annealing conditions so as to obtain no further softening than represented by the hardness as cast?

On page 11 the author stated "1 per cent. of aluminium equalled approximately 5.6 per cent. of zinc in its effect on the general physical properties."

* Mr. Smalley has already corrected this.—Ed.

The writer would suggest that Mr. Smalley should make it quite clear that his figure 5.6 was really the co-efficient of equivalence, and that when substituted for 1 in the composition, made the total over 100, so that when the new percentage came to be worked out, it would be less than 5.6 for the apparent composition; it would, in fact, be nearer to the figure 4.

On page 19 the author stated that "exfoliation" of oxide would be encountered, if special precautions were not taken in the case of brass containing high manganese. Assuming the author's term "exfoliation" to mean the interpenetration of a tenacious oxidised skin with layers of the metal, a fault to which the writer had drawn attention in the Institute of Metals Paper already mentioned, he would draw attention to the ease with which this fault could be obviated by the addition of a very small quantity of aluminium—less than 0.25 per cent.

The author's claim for the grain-size reduction effected by iron fully confirmed the writer's own experience, but he was not prepared to accept the explanation offered by the author, that it was due to the nuclear action of insoluble particles of an iron-rich compound. Manganese was readily soluble in brass, but it effected a reduction of grain-size also, and the same explanation would not hold good for a metal which went entirely into solid solution. On page 38 the author referred to a manganese-rich constituent as being responsible for embrittlement and grain-size reduction.

The writer would be glad if evidence of the existence of this constituent could be provided, and also of the alleged desulphurising influence (p. 45).

The paragraphs on heat-treatment were extremely interesting. Could the author give the size of the test-pieces heat-treated, as he would be the first to recognise the profound influence of mass on the properties of heat-treated alloys?

Further evidence in favour of the solubility of N in brass would be welcomed, as, if this were established, it would be of profound scientific and industrial importance.

In conclusion, the writer desired to express his appreciation of the Paper and his hope that the value of it would become more widely known.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Loam Moulding in Liege.

To the Editor of The Foundry Trade Journal

Sir,—I was extremely interested in Mr. Varlet's Paper on loam moulding, and feel that somebody deprived the trade of useful informatiou by limiting him in the way he states. Whilst it may be necessary to cut down some Papers, I think latitude should be allowed to foreign delegates. Perhaps a member of the Literary Committee will explain. Looking forward to further contributions from the pen of Mr. Varlet and congratulating the author on the excellence of his Paper, I am sir, yours, etc.,

"Magpie."

Newcastle.
September 26.

The Institution of Production Engineers.

Mr. Max. R. Lawrence, works manager of Messrs. The Sterling Telephone and Electric Company, Limited, Dagenham, Essex, has been re-elected as President of the Institution for the 1922-1923 session.

For the coming session papers have been arranged, the details of which will be announced shortly.

During February, however, a Paper on "Machine Moulding Methods" will be read by Mr. F. T. Hardyman, foundry manager to Messrs. Petters, Limited, Yeovil.

Local branches of the Institution have already been formed at Coventry and Newark-on-Trent, and it is hoped to inaugurate a local section at Glasgow during the coming session.

Trade Talk.

The assets of the Waltham Engineering Company, Limited, including the works, are for sale.

The imports of foreign iron ore at the Lonsdale Dock, Workington, last week amounted to 2,500 tons.

The works of the Bromford Spring Company, Queen Street, West Bromwich, have been seriously damaged by fire.

Hall & Pickles, Limited, Port Street, Manchester, are opening a new office in the District Bank Chambers, Commercial Street, Halifax.

The Metropolitan Galvanising Company, Limited, have removed their offices to the Osier Iron Works, Point Pleasant, Wandsworth, London, S.W.18.

A branch of the Shipbuilding, Engineering and Steel Commercial Staffs' Association has been formed at Stafford, and Mr. H. Poole is its first chairman.

A fire occurred recently in the premises of Boynton, Dowsett & Company, engineers' tool makers, of Goswell Road, London, E.C., doing considerable damage.

B.R.C. Fabric, made by the British Reinforced Concrete Engineering Company, Limited, Manchester, has been used for reinforcing the concrete road foundation in Piccadilly Circus.

It is now expected that the New Cransley furnaces, near Kettering, which have been closed down for the past sixteen months or more, will resume operations in the course of a week or so.

The number of vessels launched in the Tyne from January 1 to August 31 was 26, of 88,999 total net register tons, as compared with 44 vessels of 130,128 tons in the corresponding period of last year.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Birchfield Foundry Company, Chain Walk, Birchfield, Birmingham, and H. F. Spencer & Company, Prudential Chambers, Wolverhampton.

The Indian Government has sanctioned the electrification of a portion of the Bombay suburban lines of the Great Indian Peninsular Railway, the consulting engineers for which are Merz & McLellan, 32, Victoria Street, Westminster, London, S.W.1.

The opening meeting of the Birmingham Metallurgical Society took place at the Chamber of Commerce Birmingham, on Wednesday, October 4, when the president, Mr. A. J. G. Smout, delivered his inaugural address on "Waste and Inefficiency in the Metal Industry."

The English Electric Company, Limited, have been successful in obtaining a further contract amounting to £94,900 from the Preston Corporation, for the erection of the new super-generating station to be known as the Ribble Power Station. It may be recalled that the company are also supplying the large turbo-generating sets and condensers, etc., for this station. The English Electric Company, Limited, have decided to close down their Coventry works.

The demand for railway material in Colombia is likely to be heavy in the future. The National Government have to complete and equip the Pacific line, the Southern railway, the Northern railway, and the Tolima railway. The Antioquia railway will complete the line at "La Quiebra," the Amaga Railway Company propose going to the Cauca Valley, the Caldas railway from Pereira towards Manizales, the Puerto Wilches railway over 60 miles to Bucaramanga, and the Santa Marta Railway Company, Limited, the Magdalena river. The Department of Nariño propose starting its railway, and the lines from Ibague to Ambalema and Espinal to Neiva have not yet been completed.

The decision of the Ebbw Vale Steel, Iron and Coal Company, Limited, to definitely close down their important Welsh undertaking indefinitely has now taken effect. This resolution followed a strike of the miners against the price lists embodied in what is known as the Galloway award. The greater part of the steel plant was already closed down because a strike of the coke-oven men had made it impossible to feed the furnaces. The remainder of the steelworkers were paid off on Friday. Energetic efforts are being made by local leaders to induce the company to reconsider their decision, and it has been arranged that a conference, which Sir John Beynon, deputy chairman of the Ebbw Vale Company, will attend, shall be held.

Dr. H. M. Vernon, who has done invaluable work for the Industrial Fatigue Research Board, recently addressed the members of the third annual Industrial Welfare Conference at Balliol College, Oxford, on "The Importance of Keeping Records and Statistics." A system of efficient records and statistics is an integral part of the new ideas of industrial management which are steadily gaining ground. A good idea of the degree of ill-health in the workers, and its variations, could be obtained in keeping lost time records, especially if the time lost from sickness is separated from that due to other and avoidable causes. One of the chief causes of lost time lies in the accidents and injuries incurred. Hence an accurate record of all the accidents treated should be kept, and be examined statistically. The supervisor, continued Dr. Vernon, can best determine whether the workshop conditions are conducive to the maximum degree of health and efficiency in the workers by keeping exact records of the temperature of the workshops, and of the degree of ventilation. A large mass of information now exists as to the standards attained in the workshops of various industries, against which new results can be compared.

An interesting scheme for the encouragement of thrift among the workers of an engineering firm was revealed by Mr. A. F. Ferguson, of Glenfield & Kennedy, Limited, at the third annual lecture conference organised by the Industrial Welfare Society. In these days, said Mr. Ferguson, remarkably few facilities are provided for saving small amounts. The Glenfield Welfare Savings Bank, started in September, 1919, has been an assured success. A few months ago there were more than 900 active accounts, while the weekly number of deposits and withdrawals averaged over 700. At the end of the last financial year the balance in favour of depositors was more than £9,000. Deposits are made in two ways, either by direct cash payment from 6d. upwards whenever convenient to a depositor, or for those who are able to save regularly and consistently, arrangements can be made for the transfer of stated amounts from wages to the credit of the depositors' account in the Works' Savings Bank. Withdrawals are made with as great facility as deposits are made. Seven days' notice is the rule, but in the majority of cases withdrawals are paid within a day or two of notice being given and urgent cases on demand. Interest is allowed at the rate of 4 per cent. per annum on each complete pound for each complete calendar month. In 1921, as the result of the success of the Welfare Saving Scheme, the directors suggested that the employés should be given an opportunity of investing savings in the company and took powers under the company's articles of association to accept loans on deposit from employés with rates of interest varying with the rates of dividend paid from time to time on the ordinary shares. Sums are received in multiples of £1, and the minimum rate of interest is 7½ per cent. subject to tax. This rate of interest is increased by ½ per cent. for each 1 per cent. beyond 10 per cent. distributed to the ordinary shareholders. At the present time the employés have a holding in the participating Loan Account amounting to nearly £30,000.

Formation of a Section of the Institute of Metals at Swansea.

The President (Mr. Leonard Sumner), at the conclusion of the Swansea meeting, said there was one matter of importance to the Institute that he felt should be brought to the notice of the members. He referred to the possibility of the formation of a local section of the Institute. The present meeting appeared to have brought to a head an idea which had been in the minds of the Council for some time past, that the local members should express their wishes in regard to the formation of local sections. The matter had been voiced in several directions during the past few days, and he believed Prof. Edwards was now prepared to give his considered views on the subject.

Prof. C. A. Edwards said one of his chief wishes connected with the Institute holding a meeting at Swansea was that it might be the means of forming a local section in the district. He was very glad to say that after discussing the matter with a few of the more prominent members of the Institute and of the non-ferrous industries in the district they had definitely decided to take the necessary steps to form a local section of the Institute of Metals. It was hoped thereby to bring the district of Swansea more closely than had hitherto been the case in contact with the parent Institute, and it was further hoped it would be a means of encouraging other people in the district not only to take an interest in the work which was done locally, but also to become members of the Institute and help in the good work which it was carrying out.

The Institution of British Foundrymen.

A special general meeting of the members will be held at 4 p.m. on Saturday, October 7, at the College of Technology, Sackville Street, Manchester, for the following purposes:—(1) To approve the new by-laws prepared in connection with the Royal Charter; (2) election of senior vice-president; (3) place of next conference, 1923.

IRON AND STEEL MARKETS.

Pig-iron.

Conditions in the pig-iron industry, although showing some improvement, can hardly be regarded as entirely satisfactory, the continued slackness in such important consuming sections as founding and general engineering, still limiting production much below the average of normal times as far as home requirements are concerned. In the South Staffordshire area, for instance, only a proportion of the existing smelting plants are working, and, so far, there are no indications of additional furnaces going into blast in the near future. Here, however, it is satisfactory to note some improvement in demand for foundry iron both for light and heavy castings, but, on the other hand, the sale of forge quality leaves much to be desired, the recent slight improvement in inquiry for that description of pig not having been maintained. The continued stagnation in the manufacturing branches has, of course, an adverse effect upon pig-iron demand in the Midland centres of trade, where the export outlet is comparatively limited, and until a more general revival of business is established there can be little encouragement for increased production. Prices in the Birmingham market, however, remain firm, quotations for the principal brands being maintained at recent values The Scotch pig-iron market shows a diminution of recent activity in the export section, due to a slackening of the American inquiry, but in the meantime, ironmasters have full order books, and the tendency of prices continues firm. As regards home consumption on Clydeside, there is a slightly better outlook for the foundries turning out light castings, where orders are on a somewhat heavier scale than of late. There is also a better demand for steel-making pig, Scotch hematite remaining firm at 107s. 6d. per ton, with, however, the possibility of concessions in the case of substantial tonnages. In the Cleveland iron market, makers' stocks of No. 3 quality are almost exhausted, and last week supplies for prompt delivery were unobtainable. No. 1 is even scarcer than No. 3, and with No. 4 foundry now being drawn upon for export, No. 4 forge is the only description, with the exception of mottled and white, of which makers have a considerable amount on hand. With regard to No. 3, the September make is entirely sold out, and some makers are sold over the whole of October. The general quotation is now 95s., but it is possible to shade this figure for forward deliveries. Meanwhile, although sales in Scotland, as stated above, are reported to be rather better, home consumers are inclined to hold off in the expectation of lower prices as soon as the American demand is off the market. Pig-iron shipments this month look like being abnormally heavy. Boats were stemmed last week for 28,000 tons for the United States and Canada, the bulk of this being special foundry iron, and the remainder No. 3 and No. 4 The September shipments up to and including the 19th inst amounted to 22,683 tons, as compared with 16,265 tons in the corresponding period of August. Makers can now sell their current limited make at a good remunerative figure. No. 1 and silicious, for the very small quantities that come into the market, readily realise 97s. 6d., and 95s. is the general quotation for No. 3, though this figure can be shaded for forward shipment. No. 4 foundry has stiffened to 90s., but No. 4 forge is still obtainable at round about 85s., with mottled and white in the region of 82s. 6d. per ton.

Under the influence of a little more inquiry from America, together with rising coke prices, hematite quotations show a rather improving tendency. It is an altogether unprecedented position that hematite should actually be shillings cheaper than foundry iron. The demand from America, however, does not yet amount to very much, special analyses being mostly insisted upon. The home demand is still on the moderate side, but trade with the Continent, though small in volume, is steady. E.C. mixed numbers at last week's market were rather firmer at about 89s., with 6d. more for the No. 1 quality. On the North-West Coast the hematite market is firm, and indicates a tendency to better business. Bessemer mixed numbers are quoted at 100s. per ton delivered at Glasgow and Sheffield and for export at 95s. per ton. f.o.b.

Finished Iron.

The near approach of the last quarter finds little prospect of immediate improvement in the various branches of the finished iron industry, which might encourage the promise of an early revival of general demand, indispensable if production is to be resumed on a profitable basis. Unfortunately, reports from the principal centres of manufacture point in quite the other direction, and all optimistic conjectures of renewed activity in the coming autumn appear likely to be disappointed. Prices are generally upheld by the high cost of production, but North-East Coast bar iron prices have reduced their prices by 10s. For a long time there has not been a reasonable profit on transactions. In South Staffordshire the industry is still suffering from the introduction of the eight hours shift, which, when all is said, does not give the volume of production necessary to average down costs. If the finished iron industry is to continue on any important scale, some steps will have to be taken to remove this defect. The marked bar trade is fairly steady, but good crown bars are in poor request. The price at which they are quoted is not attractive if the quality of the product is to be maintained. There is a moderate demand for small lots of bars of secondary quality and for fencing iron, the latter at £10 to £10 2s. 6d., but nut and bolt iron is still very quiet compared with what it was prior to the holiday. Conditions in the foundry branch are much the same as outlined in the case of finished material, the slow progress of returning activity in the engineering departments greatly retarding any general revival of demand for metal castings.

Steel.

Movements in most sections of the steel trade have been naturally affected by political conditions in the Near East, and export business has, in consequence, been on a more restricted scale during the past week, while the confirmation of the passing of the United States Tariff Bill has been a further factor in checking activity in placing orders for shipment across the Atlantic. As far as the ferro-alloy market is concerned, the effect of the tariff on this class of raw material remains to be seen, but works are still busy with a fair amount of business for ferro-manganese from the Continent, and more particularly Belgium. Prices remain unaltered, for both home and export trade. At Sheffield the improvement recently reported in the industry is maintained, but without further expansion of business. A fairly good market for mild steels is reported, and in this section there is now very slight competition from the Continent. A better inquiry is in circulation for crucible steel, and only now and again are Government surplus lots encountered. Supplies from this source must now be nearing exhaustion, for which producers will be thankful. A fair volume of business is coming forward for motor and railway steel. In South Wales the closing down of the Ebbw Vale Works must seriously affect the local steel trade, and should the negotiations between the firm and their employés fail in effecting an agreement of a stable character, the future outlook of the industry is most discouraging. The demand for steel and tinplate bars is very slack, and some of the works are becoming short of immediate specifications The Association price is unchanged at £7 7s. 6d. per ton. In soft steel billets very little new business has been done, and orders are difficult to obtain. Steel rails continue to be very quiet, and any business done has been confined to light sections for colliery purposes. A slightly better tendency iis apparent in the tinplate trade, but insufficient to influence any movement in values. If anything, forward quotations are inclined to ease, but generally makers declare that when their order books are exhausted they will close their works rather than reduce prices further. Spot plates are generally quoted at 19s. 3d. basis, but 19s. has been accepted for the last quarter.

Scrap.

Business in the scrap metal markets continues much the same as within the past few weeks; in some districts a little more active demand is being noted, while others remain dull and featureless. At Middlesbrough heavy steel scrap is in rather stronger demand. There is more inquiry from the works, and supplies to suitable specifications are not easily arranged. Consequently, the price has improved from recent values, and is now nearer 65s. than 62s. 6d., delivered works. Steel turnings and cast-iron borings are scarce, and now realise 50s. per ton, delivered. Business in other qualities is quiet at about the following delivered prices :—Heavy cast-iron machinery scrap, 70s.; heavy wrought iron bushelling scrap, 52s. 6d.; ditto, piling, 60s.; specially selected heavy forge, 70s. to 75s. per ton.

Metals.

Copper.—Movements in the standard copper market last week showed some weakening in values, operators being reluctant to commit themselves pending developments in the Near East crisis. The settlement of the industrial disputes in the U.S.A. has been the only satisfactory feature during a period in which political crises have succeeded each other in bewildering rapidity. Electrolytic copper has lately been held firmly in America, but sales have been reported at a shade a little under 14 cents. An increasing volume of business has been passing in refined copper in this country, but Continental inquiry has fallen off for the time being. Current quotations :—Cash : Wednesday, £62 12s. 6d. ; Thursday, £62 12s. 6d. ; Friday, £62 17s. 6d. ; Monday, £63 5s. ; Tuesday, £63 2s. 6d. *Three Months* : Wednesday, £63 5s. ; Thursday, £63 5s. ; Friday, £63 7s. 6d. ; Monday, £63 15s. ; Tuesday, £63 15s.

Tin.—The uncertainty of the political situation has had only a modified effect upon business in standard tin, and values, though somewhat disturbed, have fluctuated within a comparatively narrow range. The East has sold steadily at small premiums over standard, the total for the past week being 900 tons. Banca and Chinese are being held for a higher market, and English common is commanding relatively full prices. Operations in standard tin have been influenced to some extent by the political outlook, but fluctuations have not been wide. Owing to more free lending of warrants, the contango on three months has increased to 25s. per ton. The practical settlement of industrial troubles in the United States has coincided with increased purchases of tin in New York, and the prospects for active consumption there are improved. The output of American tinplate mills is now roughly 40 per cent. in excess of the 1914 production. Current quotations :—*Cash* : Wednesday, £159 ; Thursday, £160 10s. ; Friday, £161 ; Monday, £161 10s. ; Tuesday, £161 5s. *Three Months* : Wednesday, £160 5s. ; Thursday, £161 15s. ; Friday, £162 5s. ; Monday, £162 15s. ; Tuesday, £162 10s.

Spelter.—Inquiry for this metal of late has been only on a moderate scale, and values have weakened to a small extent. On the other hand, in America, the market is distinctly strong. Stocks have been heavily drawn upon, and there the price-level is high above the parity of values ruling here. Reports from Scandinavia speak of a better demand, and of the small chance of metal being available for export. Current quotations :—*Ordinary* : Wednesday, £31 12s. 6d. ; Thursday, £31 17s. 6d. ; Friday, £32 5s. ; Monday, £32 7s. 6d. ; Tuesday, £32 5s.

Lead.—The market for soft foreign pig continues quiet and steady, with an easier tendency in the prompt position. While Mexican shipments to Europe may be augmented during the next few months, owing to the new tariff imposed in the U.S.A., production in Spain and Australia does not at the present moment appear to be increasing. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 5s. ; Thursday, £24 5s. ; Friday, £23 15s. ; Monday, £24 ; Tuesday, £23 18s. 9d.

Company News.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Interim dividend on ordinary, 6d. per share, less tax.

National Engineering Company, Limited, 1, West Bute Street, Cardiff.—Capital £10,000 in £1 shares. Director: P. C. Phillips.

Bruce Peebles & Company, Limited.—Dividend, 7½ per cent. per annum, less tax, on 7½ per cent. cumulative participating preference shares.

G. Haslam & Company, Limited, 51, Broadway, Leigh-on-Sea.—Engineers. Capital £2,000 in £1 shares. Directors: G. S. Haslam and W. G. Haslam.

Fredk. Mountford (Birmingham), Limited, 38, Moseley Street, Birmingham.—Engineers. Capital £10,000 in £1 shares. Director: F. Mountford.

Central Foundry Company, Limited, 46, Furnace Hill, Sheffield.—Capital £5,000 in £1 shares. Directors: J. Abson, F. B. Abson and F. Chamberlain.

Great West Engineering Company, Limited, Park House, Boston Road, Brentford.—Capital £3,000. Directors: O. M. Shepherd, G. W. and N. C. Stephenson.

Howard Pneumatic Engineering Company, Limited.—Capital £13,000 in £1 shares. Directors: S. E. Thornton, A. Howard, S. M. J. Nugent and P. C. Bird.

Lovetts, Limited, 418, Romford Road, Forest Gate, E.—Engineers. Capital £12,000 in £1 shares. Directors: C. E. Lovett, H. R. Bleesby, and R. R. Wilkins.

Albert E. Hargreaves, Limited, 124-6, Morrington Road, Bolton, Lancs.—Engineers. Capital £3,000 in £1 shares. Directors: A. E. Hargreaves, E. Hargreaves, H. Haughton and A. Jonas.

Stothert & Pitt, Limited.—Profit, £23,658; brought forward, £5,153; total, £33,811; final ordinary dividend, 7½ per cent., free of tax, making 12½ per cent., free of tax, for year; carry forward, £7,020.

Steel Company of Scotland, Limited.—Dividend, 12½ per cent., less tax, for year; depreciation of steel works' plant, £40,000; depreciation of collieries, dwelling-houses and lands, £7,600; reserve, £25,000; carried forward £160,058.

Gazette.

Messrs. G. B. Vickers & J. H. Baker, engineers, 94, Worsley Road, Patricroft, Manchester, trading under the style of Vickers, Baker & Company, have dissolved partnership.

North Somerset Engineering Company, Limited.—It has been resolved that the company be wound up voluntarily. Mr. D. Owen, 47, Milsom Street, Bath, C.A., has been appointed liquidator.

Simoon Engineering Company, Limited (late Julien and Grebert Engineering Company, Limited), London, W.C., in liquidation. Mr. H. C. Chambers, 5, Chancery Lane, W.C., C.A., has been appointed receiver.

Messrs. J. C. Fergusson and H. Walker, civil and mechanical engineers, 7, Gloucester Square, Southampton, trading under the style of the British East Africa and Uganda Settlers' Agents, have dissolved partnership.

Trading in the style of Abernethy & Company, Messrs. T. C. Storey, W. Abernethy & R. Macdonald, 40, Brand Street, Lorne Square, Govan, Glasgow, blacksmiths, general engineers and sheet-iron workers, have dissolved partnership. Debts by Messrs. W. Abernethy and R. Macdonald, who continue the business as Abernethy & Macdonald.

Contracts Open.

Bangkok, January 31.—Stores, for the Siam State Railways. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Bridgend, October 2.—Providing and laying about 107 lin. yards of 4-in. and 442 lin. yards of 3-in. diameter cast-iron mains, etc., for the Mid-Glamorgan Water Board. Mr. E. W. Davies, superintendent and manager, Water Board Offices, Bridgend. (Fee, £1 1s., returnable.)

Cachoeira, Brazil, October 24.—The municipality of Cachoeira require six centrifugal pumps with electric motors, cast-iron and galvanised iron piping, cement and earthenware piping, etc, in connection with the sewerage system of the town of Cachoeira. The Municipal Public Works Office.

Personal.

The late Mr. James Primrose, sole partner of Primrose & Company, ironfounders, Leith, left £23,047.

The late Mr. A. H. Shenton, of "The Grange," Little Sutton, Sutton Coldfield, ironmaster, left estate of the gross value of £3,723.

Mr. J. Cauthery has resigned his position as chief engineer to the Spearing Boiler Company, Limited, 20, Kingsway, London, W.C.2.

The late Mr. J. M. Draper, a director of the Rhondda Engineering & Mining Company, Limited, the Manchester Minerals Tributes, Limited, and Sheppard & Sons, Limited, left £5,138.

Mr. William Smith, chairman and managing director of Thomas Smith & Sons, of Saltley, Limited, drop forgers, who died on June 23, left estate of the gross value of £64,318, with net personalty £63,589.

Publications Received.

Consett Iron Company, Limited, Consett, Co. Durham. Price list of silica and firebricks for September.

The Decimal Educator, published by the Decimal Association, Finsbury Pavement House, E.C. 2., price 6d. The current number of the "Decimal Educator" contains the inaugural address of the President, Sir Richard Gregory.

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Contents.

	PAGE
A National Engineering Organisation	271
Institution of British Foundrymen—Metallurgy and the Foundry	272
An Apprenticeship Course in Foundry Practice.—XII.	276
Italian Iron and Steel Industry	278
Canadian Notes	278
An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands	279
Institute of Metals	282
Turbine Steam Chest Troubles	283
Bricks from Blast-Furnace Slag	284
The Boom of the German Iron Market	285
Contracts Open	285
Deaths	285
Trade Talk	286
Company News	286
Iron and Steel Markets	288

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

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General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.

Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.

Birmingham: D. Wilkinson, 1,114, Bristol Road, Northfield, Birmingham.

Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.

Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.

London: V. C. Faulkner, 21, Stanley Gardens, W.11.

Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.

East Midlands: H. Bunting, 17, Marcus Street, Derby.

Coventry: J. M. Meston, 37, Melville Road.

West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

A National Engineering Organisation.

There is a movement on foot to co-relate, or associate in some as yet undefined manner, the activities of the various engineering societies of Great Britain and Ireland. Already four of the most important—the Institutions of Civil, Mechanical and Electrical Engineers, together with the Society of Naval Architects, have formed a joint council, the objects of which are not too clear, but which are commonly supposed to be intimately associated with status. Last Friday, as announced in our columns, a meeting, headed by the Society of Engineers, was convened, at which the representatives of various national and provincial organisations were present. Amongst the matters tentatively put forward was an annual congress, where mining, sanitary, automobile, marine, metallurgical, and other engineers could meet together and discuss—platitudes, but little else. Another suggestion was a tome to contain the proceedings of these various societies. If the scheme is well supported, and, say, half the 200 engineering and kindred societies of Great Britain become adherents, then, assuming each constituent member has eight meetings, and each meeting only takes up ten pages, it would produce a book of no less than 8,000 pages. The value of the book when finished, no matter how prepared, would vary indirectly with the size. However, a committee of seven, which includes a representative of the Women's Engineering Society, has been drawn up to formulate a constitution, which is to be submitted to the societies concerned. Is the Institution of British Foundrymen concerned? Would an association such as this help in the co-operation between the drawing office, pattern shop and foundry? We doubt it. Would it give the foundryman such a knowledge of the various branches of engineering that it would help him to produce better and cheaper castings? This, again, is doubtful. Conversely, is engineering going to benefit by the inclusion of foundrymen in any national scheme such as can be visualised? Here, again, doubt exists. We are prepared to hear from the supporters of the scheme that such systems have been successfuly operated in Austria and Germany. But between Great Britain and Germany a basic difference is in existence. Every engineer in Germany, to earn the title, must have a college training. Just as it is practically impossible to become a medical man by working as a dispenser in the day time and study medicine at evening classes in this country, so in Germany it is practically impossible to earn the title of "Ingenieure" by part-time study. Thus all "engineers" are of the same standing. In this country, which has been an industrial State for several generations, there has grown up a system of evening classes in most of the largest centres, which undoubtedly can impart to a willing student in five or six years exactly the same knowledge as is given to a day student in three or four years, thus breaking down the Continental conception of an engineer. The advantage always rests with the hard-working evening student because his theory is reinforced by practice.

It was emphasised at the meeting that a national association of engineers could speak to the public with one voice. We have yet to learn that engineers, as Britishers understand the word, ever can speak with one voice. There is little community of interests between marine and mining engineers or between automobile and water engineers.

Another feature in favour of the scheme is the standardisation of material and specifications for their acceptation. At the moment this work is adequately tackled by the Engineering Standards Committee, which is always only too anxious to co-opt representatives from interested societies.

There is just one feature, which perhaps looks attractive on paper; that is, a scheme may be evolved whereby a member of an affiliated society could visit the meetings of all other affiliated societies. In practice, if a person wishes to attend a meeting of a technical society of which he is not a member, he can usually be introduced.

Finally, does the British mentality, which has evolved some 200 engineering and allied technical societies, really require that they should be co-related? We admit that the Football Association has done much for Association football, but the Rugby Association still flourishes. We are prepared to support any scheme for the co-relation of mechanicals, electricals, civils, or any other type of engineering separately, but not a general council embracing the whole. Each branch of engineering in this country is sufficiently large to cater adequately for its own national technical needs.

Institution of British Foundrymen.

LONDON BRANCH.

The first meeting of the Session was held last Thursday at the Institute of Marine Engineers. The chair was taken by the retiring President, Mr. H. O. Slater, who congratulated the Branch on the excellent choice of a president. In Mr. W. Lambert they had combined all the necessary attributes of a president. He was both a ferrous and non-ferrous metallurgist. He had travelled extensively, which endowed him with that broadness of vision so desirable in a president. Lastly, though a man of considerable scientific attainments, he had the happy knack of making abstruse subjects appear elementary. He then called upon Mr. Lambert to deliver his presidential address, the title of which was "Metallurgy and the Foundry."

Mr. Lambert then delivered the following address:—

PRESIDENTIAL ADDRESS.

Metallurgy and the Foundry.

Mr. Slater and Gentlemen,—I am deeply sensible of the honour of being placed in this chair as President of the London Branch of the Chartered Institution of British Foundrymen. My pride is greater because I recognise that the occupancy of this chair is no sinecure. The London Branch of the I.B.F.—thanks to the indefatigable energy and personality of our hard-working Hon. Secretary, Mr. Faulkner—is, to-day, very much alive, and it is my intention, health and circumstances permitting, to do my utmost to further the interests of this Branch.

In view of the fact that the proposed Annual Convention of the members of the Institution as a whole may after all very possibly be held next year in this city, your officers and Council—and in parentheses I may say that no Branch of any parent Institution in the United Kingdom has a more loyal, genial and enthusiastic Council—your officers and Council are particularly desirous of enthusing every one of the members of the London Branch to big efforts during the next few months, so that this Branch may possess that degree of dignity, strength and courage which may well cause envy in the breasts of the officers of all the visiting Branches.

We want to enrol a number of new members, and to rope in all such as are qualified and desirable. I use the word desirable in its broadest sense. We must not forget the honour which has been conferred on the Institution by the granting of a Charter by His Majesty King George V., and it behoves us each and all to preserve the dignity of our Branch, and at the same time to promote the intellectual welfare of the members of the Branch in accordance with the objects of the Institution as set forth in the Royal Charter.

I have attended almost every meeting of the Branch and also the Council meetings held during the last twelve months, and I am very pleased to bear testimony this evening to the zealous energy of those gentlemen who hold office or serve on the Council. The Branch generally owes them each and all a debt of gratitude for their self-sacrificing efforts, and for the many attendances at the Council meetings, the latter often at very considerable personal inconvenience.

Reverting to my previous remarks relative to my occupancy of the Presidential chair for the ensuing year, it is not within my knowledge whether, as a metallurgist, I am the first member of my profession to have the honour of being placed in this position, but I must confess to having had a little compunction in accepting the position of Vice-President a year or so ago, foreseeing as I did that the time would probably come when, in the ordinary course of events, I should be proposed to this Chair. I felt that to take the office referred to was to some extent usurping the throne of the Foundrymen, inasmuch as I am not a full-blooded foundryman in the restricted sense, but only a works metallurgist. But after all, what is a metallurgist, and in what relation should he stand to the foundry industry?

What is a Metallurgist?

The shortest definition I can offer is, one who is learned in the science of metallurgy. This definition does not take one much farther unless we arrive at the definition of the word "metallurgy." Metallurgy may be defined as the science of metals—comprising the processes for the extraction or winning of metals from their ores, and for rendering such metals suitable for use in the arts and crafts; likewise the processes involved in working such metals, and the determination of the physical and mechanical properties of each metal. Further, the processes involved in the compounding together of two or more metals or of metals with non-metallic elements, and the study of the properties and application of such complex bodies.

The works metallurgist must be a trained observer and an experimentalist. He must be able to bring a keen, analytical mind to bear upon shop problems; he should possess imagination and be able to reason by induction. Constructive criticism rather than destructive criticism should be his motto.

Roll of the Works Metallurgist.

Secondly, in what relation should the works metallurgist stand to the foundry? The works metallurgist should be regarded as having a position comparable with that of a King's Counsel—working with a brief one day for the employer, and on another day with a brief for the foundry foreman, but never assuming the rôle of a criminal detective or that of a policeman. He must at all times be able to command and hold the confidence and respect of both his principals and the works staff.

It may be of interest if I just recite a list of the subjects in which a student must qualify to obtain the Diploma in Metallurgy of the Royal School of Mines, at South Kensington:—Chemistry, physics, mathematics, mechanics, applied mechanics, applied electricity, geology, metallurgy—ferrous and non-ferrous, assaying—ferrous and non-ferrous, metallography, electro metallurgy, hydro metallurgy, ore dressing, physical chemistry, machine drawing, furnace drawing and design, refractory materials, fuel, mineralogy and graphs.

I do not believe that the workshop is the only school in which to receive a training, but I certainly am firmly of opinion that the works metallurgist who is content to assume that his college training is the alpha and omega of his profession, and shuts himself up in the works laboratory will never make an ideal works metallurgist.

An intimate knowledge of the details of works practice, and, if possible, a greater knowledge of human nature, gleaned from close association amongst the craftsmen practising the arts and crafts of metallurgy, is most essential if one bids for success as a works metallurgist.

To ask, Why do you want to know? before answering a question, too often causes an inquirer to close up like an oyster; whereas, a willing reply by the one addressed will, more often than not, lead to an open confidence, resulting, frequently, in mutual benefit to both parties. With children even, one may often notice that if, when a question is put, it is met with the words, "Why do you want to know?" the child replies, "Oh! it doesn't matter, I only wondered"; maybe, what might have proved an interesting confidence has been nipped in the bud.

The Workshop of the Metallurgist.

The workshop of the metallurgist is known as the laboratory. The works laboratory should not be a closed department so far as the foundry foreman is concerned. He should be encouraged to seek the co-operation of the laboratory, and the foundry foreman on his part should endeavour as far as possible to keep the laboratory in touch with both the successes and the failures in workshop practice. Mutual confidence must be established if the best output is desired.

I am quoting from a leading article of one of the contemporary engineering journals. "We must take the Institutions as we find them, and admitting that they fall in some measure from perfect grace, we cannot but recognise that even the Institute of Metals would benefit by occasional elementary lectures on the principles of the relatively new science of metal."

If the Institute of Metals, so also the Institution of British Foundrymen, and, if the Institu-

tion as a whole is to benefit, it can only do so through its individual members. Therefore, I am optimistic enough to believe that the London Branch will welcome occasional elementary lectures on the principles of the relatively new science of metal.

What is a Metal?

Has each one present here this evening ever put pen to paper and tried to write out the definition of a "metal"?

What is a metal? Surely you will agree that this is quite an elementary question, and yet, after thirty years intimate association with "all sorts and conditions" of metals, I confess to being unable to give a really satisfactory definition of the word "metal." One authority has written: "The term metal is more convential than strictly scientific": the word, therefore, does not permit of a strictly accurate definition.

Over sixty metals are at present known, yet as recently as the days of good Queen Bess, only seven metals were known. This statement alone gives some idea as to what we all owe to the scientist. The possible number of combinations which can be provided by compounding together two or more of these elementary metals in varying proportions is impossible to calculate.

What exactly is one to understand by the principles of the relatively new science of metals. To answer this query in anything like a sufficiently comprehensive manner would take many hours, and a far better exponent than myself.

However, I propose to attempt to enumerate briefly and in simple language one or two of the more recent methods of investigation which have been employed to advance the science of metallurgy, and to enable the principles of the relatively new science of metals to be propounded.

Microscopy.

This word is derived from the Greek "micro," small. The study of the small structure of material. You are all familiar with the reproductions of photomicrographs showing the microstructure of metals and alloys. Almost all the present-day literature on metallurgical subjects has its pages interspersed with micrographs. Several members among us this evening are expert metallographists. The value of the information gleaned from a study of the micro-structure of a metal or alloy is nowadays recognised without question. Do you realise that this method of investigating certain characteristics of the metals and alloys was only established two or three decades ago (1894).

For the microscopic examination of metals, the surface of a suitable section of the metal is brought to a fine finish by either filing, grinding, or the use of various grades of emery and other abrasives mounted on cloth or paper, and is then prepared for examination by one or other of the following methods:—

Bas Relief.—In which the softer constituents are worn down, and the harder are left in relief.

Polish Attack.—Combining both bas relief polish and attack by a weak etching medium.

Electrolytic Etching.—The specimen being placed in an electrolyte—a liquid which will conduct an electric current—the surface of the specimen can then by suitable means be either eaten away in parts or plated in parts, which serves to differentiate between the various constituents.

Heat Tinting.—By which colour variations of the surfaces of the constituents are produced, which effect is brought about by the degree of surface oxidation due to the time and the temperature to which the specimen is exposed.

Tarnish Effect.—The degree of discolouration of the constituents when the surface of the prepared specimen is exposed to certain gases such as sulphurated hydrogen (H_2S.).

Other methods suggest themselves, and are occasionally used, but need not be enumerated.

In view of the fact that metals, unless in extremely thin sheets are opaque to light, it is necessary to examine the subject either by oblique or vertical lighting, and in order to explain to the uninitiated the *modus operandi* by which the microscopic examination of an opaque object is possible, microscopes and diagrams have been brought to the lecture hall, and each one of you can have a personal demonstration.

The next question is, what does the microscope reveal? It shows us (1) Grain size and characteristics of the grain, such as core effects, etc.; (2) the structure (phases); (3) constituent metals when occurring uncombined; (4) segregations; (5) foreign matter; and (6) crystal cleavages, inter granular porosities, gas holes, slip bands, etc.

Macroscopy.

This word is derived from the Greek "macro," large. The study of the coarse structure, etc., of material. As in the case of the examination of the micro-structure, it is necessary to have a prepared surface, but in this instance the surface, if a polished one, will not require to be finished to anything like the extent of that required for microscopic examination. The prepared surface is then either eaten into by an etching reagent, or by the abrasive action of some specific medium used under pressure. Heat effects on the surface, and also tarnish effects may likewise afford a means of differentiating and identifying certain constituents or segregated masses.

In the first method, the structure developed, results from the relative degree of solution of the various constituents in the etching fluid. In the second, it is the selective resistance to the action of abrasive which serves to distinguish between the constituents, and in the third method it is the relative rate of oxidation, and the depth of the oxide films produced on the surfaces of the various constituents which serves as a means of identification. In the fourth case, it is the discolouring effects of certain reagents when applied at normal temperatures.

Pyrometry.

The thermo-electric couple, or more simply the thermo couple, was discovered by Serbeck in 1822, but remained dormant until revived by Le Chatelier in 1886.

The junction of any two dissimilar metals when heated is the seat of an electromotive force, which is approximately proportional to the temperature. If we unite together one end of each of two wires and connect the free ends to a delicate electrical measuring instrument—a galvanometer—then, upon heating the junction of the two wires, a movement on the indicator of the instrument can be observed, and if the scale of the instrument is calibrated to read in terms of temperature, we have at our disposal a very valuable thermometer.

The great virtue of the thermo-couple for scientific research work lies in the fact that the mass to be heated is exceedingly small. The E.M.F. (electro-motive force) generated at the junction by heat is a function of the chemical composition of the two wires, of the dissimilarity of the two metals, and not of the gauge of the wire. For high temperature determinations it is, of course, necessary to select suitable wires. The most satisfactory thermo-couple for high temperature measurements is made by joining together a pure platinum wire with one of a rhodium-platinum alloy (90 per cent. Pt + 10 per cent. Ro).

Pyrometers of the thermo-couple type are used almost exclusively in observations connected with physico-metallurgy. Recording instruments giving an autographic chart are in common use with the type of thermo-couple mentioned above, and the two in combination afford a very accurate, and at the same time fairly robust scientific instrument.

The use of the thermo-couple pyrometer for researches in physico-metallurgy, and the application of the microscope for the examination of metals, may be said to be the two predominate factors making possible and leading to the introduction of the newer science of metallurgy.

Utility of Pyrometry.

Amongst other determinations, with the thermo-couple, one can make:—

(1) Accurate determinations of the melting points (freezing points) of each of the elementary metals.

(2) The thermal effects taking place during the transition from the wholly liquid to the wholly solid states and *vice versa* of the alloys.

(3) The thermal effects taking place in solid alloys when cooled from above or when heated above or cooled below the normal temperature.

Finding Melting Points.

If we immerse a thermo-couple, suitably protected, into a small molten mass of an elementary metal such as pure copper or iron, and remove the molten mass from out of contact with the source of heat employed in melting the same, tho

metal will gradually cool down, and the indicator connected with the thermo-couple will continue to show a steady fall in temperature until the moment that the mass commences to solidify, when an appreciable arrest of the movement of tho indicator will be observable, and not until practically the whole of the mass has solidified will any considerable further downward movement of the indicator bo apparent. The scale reading at which the arrest occurs, if the instrument has been accurately calibrated, will represent the temperature of freezing of the metal—the freezing point. With all pure elementary metals, the freezing point and the melting point are identical. Pure compound metals and eutectic alloys behave as elementary metals in so far as showing a single " arrest " only, namely, at the freezing point.

With an open scale on the indicator and a series of pure metals of known melting point, covering a sufficient range, it is of course easy to calibrate an instrument for oneself by a careful observation of the arrest points of the metals constituting the series.

Liquid to Solid Thermal Changes.

As an example of the thermal changes taking place during the transition from the wholly liquid to the wholly solid state, and *vice versa*, of alloys, we may take an alloy of lead and tin. All alloys of lead (328 deg. C.) and tin (232 deg. C.) are homogeneous liquids at any temperature above the freezing point of pure lead.

When the two metals lead and tin are compounded together, it follows from the foregoing statement that the mixture will be a wholly molten homogeneous mass above a temperature of 328 deg. C. Alloyed in the proportion 27 lead: 63 tin, the freezing point is lowered to 182 deg. C., and a cooling curve of this alloy shows only one arrest in the fall of temperature during the transition stage from the liquid to the solid state.

Compounded in certain other definite proportions, two arrests are observable, before the metal becomes wholly solid, the first at which crystals are formed, either rich in lead or rich in tin according to the increase in the percentage of one or other of the two metals above the figures previously given, namely, 27 lead: 63 tin. The second arrest will occur when the *liquid metal still remaining* has arrived at the proportion of 27 lead: 63 tin, when the metal will solidify without further fall of temperature until the whole mass is set.

The mother liquid from which are deposited the lead-rich crystals or the tin-rich crystals, as the case may be, is termed the *eutectic*, and is the alloy of the lowest freezing point of the whole series of alloys, and this property being peculiar to itself, it follows that the eutectic alloy has an invariable composition.

Thermal Changes When Solid.

As an instance of the thermal observations which may be made during the heating or cooling of a solid metal, one may quote the phenomena occurring when a piece of high-carbon steel is heated to or allowed to cool from a full red heat. If we take for example a piece of carbon steel with, say, 0.9 per cent. of carbon, and insert our thermo-couple in the mass, we shall find that on heating the metal up to or cooling from a full red heat, a very appreciable " arrest " occurs at a temperature range in the neighbourhood of 700 to 750 deg. C., the precise figure depending upon the composition of the steel.

Now, we are in a position to go a step further, and by studying the equilibrium diagram or constitutional diagram representing the compounding of two or more metals to form a series of alloys, we may get an insight into the most comprehensive and satisfactory method of describing the nature and constitution of the alloys of a given system.

Unfortunately, time will not permit this evening of our constructing an ideal constitutional diagram, for even a simple two metal system, but if so desired I shall be pleased on a subsequent occasion to carry you somewhat further into the study of the constitutional and other diagrams.

The thermal analysis of metals and alloys, comprising as it does the melting and freezing points, solidification ranges, critical temperature points and ranges during which transformations in structure are taking place, has been very materially aided by the employment of electrically-heated furnaces. By far the greater amount of investigation work in connection with the thermal analysis of metals and alloys has been conducted in electric furnaces of the laboratory type.

The Electric Furnace.

In its simplest form the furnace may be described as a tube around which a metallic wire of a suitable metal is wound, and through which a current of electricity is passed. The wire becomes heated, and in turn heats the tube upon which it is wound. The wire wound tube is lagged with refractory material of low heat conductivity, such as magnesia, quartz, sand, etc. In other types of electric furnace, the material of the tube itself is the resister. The bore of tube affords the heating chamber in which the metal to be examined is placed. Crucibles can be introduced into the tube, and serve as a means of containing molten metal.

The great advantage of the electric furnace over all other types lies in the facility with which one is able to effect control of the temperature, and this, coupled with the cleanliness, compactness, and convenience of the electric furnace, makes it an almost indispensable adjunct to the laboratory.

The thermal treatment of metals as practised in the heat treatment of steel, the bronzes, and in practically all the metals and alloys used in engineering, and covering such processes as normalising, hardening, annealing, tempering, case-hardening, etc., owes much of its present-day application as a result of laboratory research, in which the microscope, pyrometer, and electric furnace have contributed invaluable aid. In hundreds of instances it is now possible to prognosticate with certainty the results to be expected if a metal or alloy is subjected to a particular process of heat treatment.

Magnetic and electrical phenomena as exhibited when metals are subjected to various treatments is not neglected, and the significance of such phenomena not only from a purely academic but from a practical point of view is carefully studied. Electrical measurements play an important part in the newer science of metallurgy, and many are the ingenious instruments employed in this class of work.

The use of X-rays as a means of examining the homogeneity of a metal must not be allowed to pass without mention.

Testing Machinery and Mechanical Testing.

The mechanical tests with which everybody connected with the metallurgical industry are best acquainted are the tensile or pulling test, the transverse or bending test, and the compression or squeezing test. These three tests have long been established, but notwithstanding this fact, every day introduces further refinements in the mechanism for conducting these tests and analysing the results obtained. To enumerate the whole of the newer testing processes would be to tax your patience perhaps unduly, but mention must be made of the more important introductions such as the single-blow impact testing machines of Frémont, Izod, Guillery, Charpy and others; the repeated blow impact test with machines of the Eden Foster and other types; repeated bending test with machines of the Sankey and the Humphrey type; hardness determinations as by the Brinnel and the Schore apparatus; tests to determine the resistance to abrasion; torsion tests; shearing tests. Even a revolving emery wheel is not despised, as evidence the " spark tests " of carbon and alloy steels. The cinematograph also has been called into service, and films have been taken showing the behaviour of test bars under varying conditions of mechanical stress.

I am afraid I have only too inadequately put before you this evening some of the things which I had in mind when drafting these notes, but I can assure everyone here this evening who has not already delved into one of the more modern treatises dealing with the newer science of metals, that the sooner he does so, the sooner he will appreciate the advance the science has made during the last few years. If read in the right spirit the subject is a most fascinating one, particularly so to the man who is daily making use of the metals as materials of construction.

In conclusion, I offer my humble services to any member of the Branch to whom I can render assistance in recommending suitable text books, or in elucidating any of the knotty points he may come up against in the literature appertaining to the newer science of metals.

Demonstration.

The President after exhibiting and explaining a large number of slides illustrating chemical, physical and mechanical testing, left the platform and demonstrated in a very practical manner a large quantity of scientific apparatus brought from his home and lent by Messrs. J. Stone & Company, Limited, of Deptford.

The Chairman said it was not usual to discuss a Presidential Address, but he invited all present to inspect the apparatus provided by the President at the close of the meeting. With regard to pyrometers, he had had a good deal of experience in the annealing of malleable iron, etc., and he had always considered that his eye was good enough to enable him to tell the temperature of a metal for practical purposes. He had relied on practical experience a great deal, but that was probably because he had not properly understood the pyrometer.

Vote of Thanks.

The Secretary, in proposing a hearty vote of thanks to the President, said that the lecture had been most interesting. To him it had been a case of the revision of what he had learned at the University. If he himself were asked to judge a temperature, he would look round in order to visualise the amount of light in the particular shop, because workshops differed tremendously in regard to the amount of the light in them. There was good lighting in some, and practically no light in others, and that would influence the eye tremendously; he had great confidence in a man's eye, provided he was always on the same job. If a man were taken from a well-lighted foundry to a badly-lighted one, and asked to estimate the temperature of a metal, he would probably be at least 100 deg. C. wrong. A man could work very well without a pyrometer for weeks or months, and then, through health considerations, he would go wrong; a man's eye wanted calibrating every three months, or less, depending on the constitution of the man. That was where the value of science came in. Science was absolutely essential, but, at the same time, many professors nowadays made a serious error. They would take a system of two metals and cast alloys ranging from 1 to 99 per cent., mix them up very nicely, and then cast ingots. But it did not matter whether they were impossible castings, or good ones, because they were part of the research, and the results were published. The old-fashioned professors, if they did not make good castings initially, they would discard them and say that if they were not good enough for commerce then they were useless for research. Unfortunately, it was found nowadays that many professors had no practical training. If a practical man asked what was the practical bearing of a particular piece of work—although admitting that it was interesting from the theoretical point of view—they were afraid to make a hazard. The professors were just as frightened of the practical men as the practical men were of the professors, and if a practical man told a professor that the results of an experiment in practice were different from the theoretical results, the latter would doubt his own results. Therefore, it was time the various grades co-operated—practical, technical and academic. It was possible for the academic man to become technical and for the practical man to become technical. Here they could meet on common ground for the general good of the industry.

Mr. J. Ellis seconded the vote of thanks. The best thanks of the Branch were due to Mr. Lambert for having brought so much apparatus for their inspection. It must have cost a great deal of time, money and trouble to have prepared the lecture in such a manner that it could be understood easily by the members. He quite agreed with Mr. Faulkner as to the academic gentleman and the practical man. That was the essence of the existence of the Institution of British Foundrymen. The practical men started it, although some of the professors liked to say now that it had its birth at the University of Birmingham; that was not so. It was started by purely practical men, and their object was to try to teach the academic gentlemen; it was not so much for the academic gentlemen to come and teach the practical men, because, after all, the academic gentlemen have never made a good casting. Practical men have made many wasters, but they have made a great many good castings. But the time had come, he said, when the practical men were being recognised, and the academic gentlemen were coming amongst them and giving them the benefit of their knowledge, if the practical men, on the other side, would give the academic gentlemen the benefit of their knowledge. It was only by the combination of the two that the true results for which the Institution of British Foundrymen was working would be achieved.

The vote of thanks was carried with acclamation.

The President's Reply.

The Branch-President, in thanking the members, referred to Mr. Faulkner's remarks. He (the President) did not pose as an academic man; he had been a humble works metallurgist for the past 30 years. He had found that scientific apparatus was of use to him, and he had done his best to introduce such apparatus, where he considered it was necessary, into the workshop—he would not say to try to educate the workshop man, but to try to lead him to regard scientific apparatus, not as being something which he could not understand anything about because he had not been scientifically trained, but as an adjunct to his work. There was no doubt that the time had come when pyrometers had got to be used. It was all very well for Mr. Slater to say he had confidence in his eye, and that he knew when a metal was at a temperature of 1,000 deg., but he must have had some instrument in the first place with which to measure it; otherwise, how would he have known that it was 1,000 deg.? He was very delighted to have given his lecture, because he wanted to drive away the bogie of what foundrymen called science. There was no bogie about it at all. They must take it in their hands and grasp it, get hold of good books on the subject, and try to understand it. If they came across knotty problems which they could not follow, he would be pleased to help them to elucidate them if they would come to him. There was a fascination about foundry work, and some of his happiest moments had been spent on the stage of a steel furnace; if foundrymen would study the application of science to the foundry, they would find that there was a great great deal more fascination in it than otherwise. As illustrating the relations between the academic and the practical man, he said he had called upon an academic man some time previously, who had shown him a valve casting made in aluminium bronze, and told him that it would stand a test up to 2,000 lbs. He had asked the academic man how many castings he had made before he had obtained the particular one referred to, and was told that he was the first man who had asked that question.

Forthcoming Events.

OCTOBER 5.

Institution of British Foundrymen (London Branch) :—"The Manufacture of Locomotive Superheater Cylinders," by A. F. Gibbs.

OCTOBER 7.

Institution of British Foundrymen (Lancashire Branch) :—Ordinary meeting at Manchester. Presidential address by John Haigh (Branch President). "The Handling of Foundry Materials," Paper by Mr. Haigh.

Institution of British Foundrymen (London Branch) :—Visit to the works of Messrs. Fraser & Chalmers, Erith.

OCTOBER 10.

Institute of Metals (Birmingham Local Section).—Address by F. Johnson, D.Sc. (Chairman).

Institute of Metals (Scottish Local Section).—Meeting at Glasgow. Address by James Steven (Chairman).

Sheffield Association of Metallurgists and Metallurgical Chemists :—Ordinary meeting at Sheffield. "Atomic Structures," Paper by J. Woolman, M.Sc.

OCTOBER 11.

Institution of Automobile Engineers :—Presidential address by Lt.-Col. D. J. Smith.

OCTOBER 12.

Society of Chemical Industry (Bristol Section) :—Ordinary meeting at Bristol. "The Importance of the Chemist to the Nation." Address by Dr. E. F. Armstrong.

Institute of Metals (London Local Section) :—Address by D. Hanson, D.Sc. (Chairman).

OCTOBER 13.

Institute of Metals (Sheffield Local Section) :—Postponed annual general meeting at Sheffield University, followed by Paper on "Non-ferrous Foundry Practice," by P. Longmuir, D.Met.

An Apprenticeship Course in Foundry Practice.—XII.

By Ben Shaw and James Edgar.

METHODS USED IN PATTERN CONSTRUCTION.

PART I.

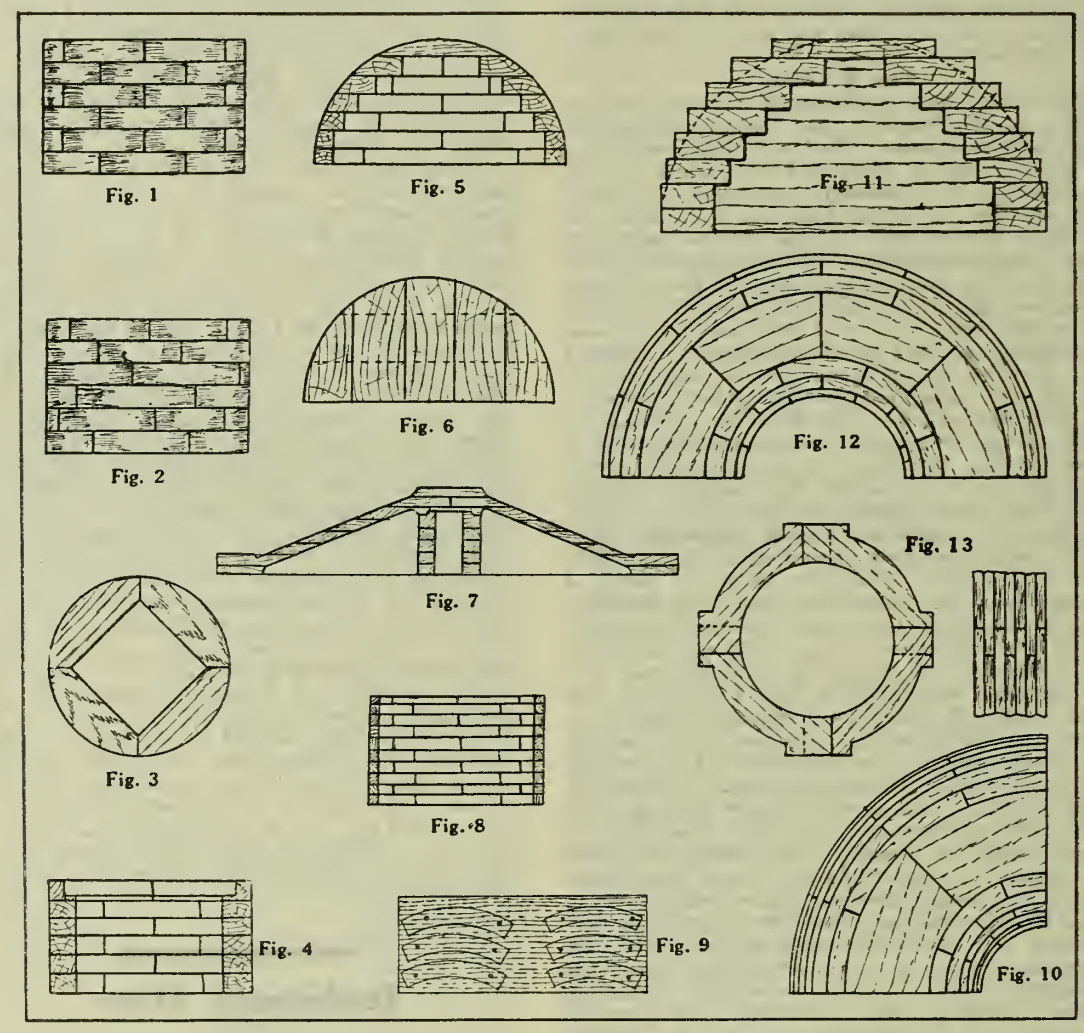
With small work the patternmaker may have no choice as to the method of construction adopted, unless it be a question of using a block print as an alternative to a loose piece, but with nearly all jobs, apart from details, it is possible to construct them by various methods, and judgment based on experience and skill can alone determine which is the best method to adopt. There are several important points to be considered before the work is started. The number of castings that are required should always be borne in mind, because it is obviously absurd to make a flimsy pattern, suitable for a one-off job, when the pattern will be used over a long period, and it is likewise wasteful to adopt expensive methods of construction if only one or two castings are required. It is, however, sometimes necessary to make an exceptionally good pattern because of the foundry being a considerable distance away, rendering it difficult for the moulder to consult the patternmaker or to get the pattern repaired, in the event of an accident. Foundry equipment has also to be considered. It is futile to supply loam boards for a cylindrical job to a foundry that has no equipment for loam work. It is not unusual for foundries to return patterns to be altered, or even reconstructed, because they have not been made so that they can be moulded with the tackle available, and especially is this true of large work.

All patterns should be designed with a view to the elimination of hand work as much as possible. This is a policy which is resented by many craftsmen, but it is possible, within the limits imposed by such a principle, to be an artist, and the apprentice should remember that the lower the production costs are, the better it is for the industry Any advantage that may be gained by making a pattern more costly than is necessary is only a temporary one. We have known men carve work at the bench when it could have been turned in the lathe in a fraction of the time. When choice is possible, work should in nearly all cases be turned.

Grading Work.

We shall not discuss the constructional details of specific patterns in this article, but what may be termed standardised methods of construction. Some jobbing pattern shops grade work according to quality, to assist them in tendering, and it is usual for the patternmaker to form a habit of grading his work whether or not it is shop practice. It is possible to make three qualities of most large patterns and two of small patterns. A good example of grading small work is the jig pattern in the motor-car shop, as compared with a pattern of, say, the engine cylinder. One casting will be required for the jig, whereas hundreds will probably be required from the cylinder pattern; therefore not only a cheaper quality of timber can be used, probably second or third quality yellow pine instead of baywood, but the filleting of sharp corners can usually be left to the moulder. If, however, a large number of castings were required from the jig pattern it would be an economy, because of the saving of the moulder's time, to construct the pattern with all fillets, even if the degree of accuracy were not so important.

If we divide patternmaking into three classes, the cheapest is the skeleton pattern, and the other two may be graded to form first and second quality patterns.



Standardised Methods.

Skeleton patterns form a distinct class by themselves, and we shall deal with them in a special article, confining ourselves in this article to a description of the principles of lagging, staving, boxing up and segmental construction. The methods adopted in these operations are dependent, to some extent, on the quality of pattern desired, because, when a one-off pattern is being constructed, lighter timber can be used and methods of jointing which involve less labour. Details of construction are also modified, according to the quality of pattern required, but this will be best appreciated when we come to discuss building patterns. A word may not be out of place here about shell patterns. In some patternshops there is a strong prejudice in favour of shell patterns—that is patterns that leave their own cores. Much depends on foundry conditions, and also on whether a shell pattern can be more easily moulded than a block pattern and corebox; a strong argument for the shell pattern is that the correct thicknesses of metal are assured. Patterns which are required to be fitted to boilers, condensers, etc., are frequently required to be exact models of the desired castings because, after they have been fitted in place, the engineer in charge is responsible for determining the position in which the casting is to be finally located and a pattern similar in shape to the casting is more helpful.

In constructing medium sized and small cylindrical patterns, there is often a choice possible as between lagging, otherwise called staving or segments. Unless a pattern body is small it is always best to build it rather than make it from solid timber. A circular pattern may then be made as a lagged barrel, or, if it is short in length, in proportion to diameter, it may be built of laminæ of segments. An important advantage of lagging is that if the grounds to which the staves are fastened are carefully made, it will last for a very long time and, if for vertical moulding, will deliver freely from the sand. With a lagged cylinder there is no crossing of grain, but, when segments are used, the periphery does in time become somewhat irregular, and thus tears the mould. For short cylindrical bodies or parts which have to be fitted to a main body, the segmental method is generally preferable. There are exceptions of course. Segments can be quickly sawn and built. It is good practice to stave work that is of greater length than diameter.

Segmental Work.

For shapes that are irregular, or that have to be recessed in places after the work is turned, the segmental method is preferable, because the segments can be made wider locally to allow for the cutting. A much stronger pattern is made of two thicknesses of segments than by a one-thickness plate. It is not always possible, as in ordinary timber jointing, to glue "back to back"—that is with the annual rings tangent on the joint—but it certainly should be done when there are only two laminæ of segments, to ensure against warping.

Short segments are more satisfactory than long segments, although it is not advisable to make them too short, especially if there is not sufficient lap between one joint and another; on the other hand, long segments expose end grain as well as side grain to the atmosphere, and thus the periphery in course of time tends to become more irregular. Strength, and permanence of form, can only be secured by the use of segments which give an almost continuous grain, and, while the number of segments to the circle should be determined by the diameter of the work, as a general rule it may be said that they should not be more than 12 in. to 15 in. long.

If a casting pattern is wanted, and it is intended to paint or varnish it, the segments should be glued, and, although driving nails are satisfactory for general work, two-thickness jobs should invariably be screwed.

There is much difference of opinion amongst patternmakers as to whether symmetrical or staggered joints are the better. As far as appearance goes, although this should have no bearing on the matter, the job which is built with the joints of alternate courses in the same perpendicular lines looks more artistic, but it is a mistake to suppose there is no case for staggering joints. Those who advocate staggered joints urge that greater strength is obtained when no two vertical joints are in line. Too often, no proper system is adopted, nor is sufficient care taken in marking off the segments of varying lengths, hence a very weak pattern may be made. There is no real case against jointing, such as is shown in Fig. 2, and it is worthy of careful comparison with that shown in Fig. 1. We prefer symmetrical jointing chiefly because short and weak laps may be made, unless great care is taken, and thus the very object aimed at defeated, which is to secure strength by not having any two joints in the same vertical line.

Although for large work thicker segments may be used $\frac{5}{8}$ in. or 1 in. is as thick as ought to be used for the majority of patterns, and in many cases much thinner segments are advisable. Fig. 3 illustrates the diagonal cutting of segments on the inside, which is often resorted to, and which results, in many cases, in a waste of timber without any appreciable addition of strength. Two to two and a half inches is as wide as it is necessary for segments to be made, as a general rule, and for small work they may be narrower than this, and, unless the boards are so narrow that only one segment can be cut from the width, they should not be sawn as at Fig. 3.

If for any reason it is necessary to close the end of a segmentally built cylindrical pattern, it is bad practice to screw a plate on top of the segments and unnecessary to build the last two courses into the centre. The best way is that shown in section at Fig. 4, which consists of turning a recess in the last course of segments and inserting a plate which may be either sawn or pared. An alternative way to turning the recess is to secure the plate before the last course has been attached, and fit this row of segments against it.

Figs. 5 and 6 show alternate methods of building a dome, Fig. 5 being a section. The method shown at Fig. 6 is very suitable for patterns that are rather small to be segmentally built. The more common, but less satisfactory method is that indicated by dotted lines in Fig. 6. Often in building such a dome segmentally the segments are left needlessly wide to safeguard against weakness. The layers of segments should be set down on the drawing board and the diameters transferred, as the building proceeds, to the building board. The top of the dome should be in baywood, or other hardwood that shrinks less than pine.

It is not always possible to use nails in segmental work. Pegs have frequently to be used. Holes for them are bored with a pin bit, and the pegs, made square, are dipped in glue, then driven in. Fig. 7 represents a large valve cover. It would be very awkward to nail this job as, with the greatest care, nails will sometimes follow the grain of the timber, and then there would be endless trouble when turning, owing to the points of nails coming through. Some men are content to bore perpendicular holes to receive wood pegs, but a much better result is obtained by boring the holes at the angles. Such a pattern as this ought to be thoroughly dry before it is turned. It will be observed that the centre boss in the sketch has been built and turned separately, which is much easier than building the whole job at one operation. Thin segments are better for such a job as they are easier to peg. Sometimes, when building a thin and deep ring, similar to Fig. 8, reliance has to be placed entirely on the glue, which should be applied thin and hot. In ordinary building very little planing of the joint should be necessary if the planing machine and trimmer are in good condition, but, when neither nails nor pegs can be used, each course should be carefully planed to ensure a good close joint.

When making a saucer shaped pattern, similar to Fig. 7, as only six segments of each size are required, they may be marked off and sawn separately, templates being made for each course, but, when the work is parallel, and a large number of similar segments have to be sawn, three or four boards should be placed one on top of the other and the top board marked off with a template, after which, sprigs—the kind known as panel pins are suitable for thin segments—can be driven in as shown in Fig. 9. One cut of the band saw by this method gives three or four segments.

Large elbows or breeches pipes are common in some shops and they are invariably made by the skeleton method, even when a number of castings

are required, because they cannot be lagged up like a straight pipe, and they are too large to be made from solid timber. Skeleton patterns are satisfactory for one-off jobs, but if several castings are wanted, and a solid pattern can be made almost as quickly, it is certainly more profitable to make one. A very strong and comparatively cheap pattern can be made for an elbow or breeches pipe by the segmental method, with a little care. Figs. 10, 11, and 12, illustrate the construction of such patterns. Several grounds about 2 in. thick are first made, but an end view of the construction should be set out on the drawing board. The segments should not exceed about 1 in. thick and the grounds should be cut so that at no part will the pattern be less than $1\frac{3}{4}$ in. thick. The grounds have to be placed very accurately on the building or drawing board. The segments should be made so that it will be unnecessary to use a template, as template working is very slow and not more accurate. When such a pattern has been built, it can be finished with gouge and spokeshave very quickly. It will be observed that with the breeches pipe shown at Fig. 12 the construction is similar, although it is more difficult to mark off the segments. Instead of building on grounds when making elbows and other large bends by the segmental method, joint plates may be used, but it is not good practice, as it is practically certain that more trimming will be necessary with gouges and spokeshave.

The method we have been considering consists of a number of super-imposed layers with the joints alternating, similar indeed to the building of bricks. An alternative method which has the advantage of being prepared very quickly, is shown at Fig. 13. In this instance four segments only are used, and sawn larger than the required size to allow for finishing when the job is built, and the ends cut to form a series of tongues, as shown at Fig. 13. When all the ends have been cut—on the circular saw—glue can be applied to the tongues, and the segments interlocked and clamped up. It is an advantage to leave projecting pieces on the segments for this purpose. No nails or screws are needed with this method, and very little time is lost in waiting for the glue to set before cutting the work to the desired shape. This method is fairly satisfactory for rough work that is wanted quickly, but it should never be adopted for standard work or when there is time to build in laminæ of segments. Further, it is quite necessary that the pattern should be coated with paint or varnish.

Italian Iron and Steel Industry.

Capacity Figures.

In an interesting report on the present position of the Italian iron and steel industry the American Commercial Attaché at Rome (Mr. H. C. MacLean) gives figures indicating the existing capacity of the plants, and touches upon the conditions affecting Italian trade with foreign countries, mainly, of course, from the American viewpoint. We reproduce the following abstracts:

The Ilva iron and steel combination owns or controls three plants for making pig-iron, one at Bagnoli (on the Bay of Naples) with three blast furnaces; another at Portoferraio (on the island of Elba) with two; and the third at Piombino (on the mainland opposite Elba) with two. All these furnaces use coke. In addition, there are 8 small furnace plants using charcoal for special grades of iron and 14 plants producing "synthetic" iron from scrap.

Government reports enumerate 54 steel furnace plants in Italy. Their approximate full capacity is stated to amount to 1,500,000 metric tons, although the recorded maximum yearly output, attained in 1917, was only 1,331,641 metric tons. Less than 40 of these furnaces are now in operation. Provisional figures for 1921 give the total production of steel ingots and castings during the year as 683,200 tons.

In a normal year, like 1913, Italy's annual requirements might be broadly stated as 600,000 metric tons of pig-iron and 1,200,000 tons of semi-finished steel. The utmost productive capacity of Italian blast furnaces using coke can scarcely exceed 400,000 tons annually, and the furnaces supposedly good for this output are placed so as to furnish hot metal for steel production in adjoining departments of the plants to which they severally belong. For a year assumed to be normal, this would leave 200,000 tons of pig-iron, mostly of foundry grade, to be imported. [As a matter of fact, the actual output in 1921 was less than 76,000 tons of pig-iron of every kind including ferro alloys.]

Italian steel furnaces, if worked to capacity, should furnish 1,500,000, tons, as stated above, which would easily meet the requirements of a normal year. But since Italy has few merchant-steel furnaces, the latter, in general, being designed to prepare the metal for further working in the same establishments, under settled conditions imports of 200,000 to 250,000 tons of steel in the form of blooms, slabs, etc., would be needed yearly.

Canadian Notes.

According to announcements issued at Victoria, B.C., Mr. M. I. Landahl (Vancouver), one of the promoters of the Coast Range Steel Company, Limited, which plans the erection of an iron and steel smelting plant on the British Columbia Coast, states that a conference is to take place in London shortly between the officials of the Imperial Trades Facilities Committee, the Dominion Government, the Government of British Columbia, and representatives of the manufacturing interests associated with the project. The Hon. W. S. Fielding (Canadian Minister of Finance)—now at Geneva—is mentioned as the Dominion delegate; British Columbia being represented by either Hon. W. M. Sloan (Minister of Mines of the Province), or by Hon. John Hart (Provincial Minister of Finance).

An extensive body of iron ore is reported to have been discovered thirty miles north-west of Hudson Hope, Peace River, British Columbia. Samples of the ore assayed 60 per cent. iron, and proved to be self-fluxing. In contiguous territory there are large deposits of high-grade coking coal.

Prices of all kinds of iron and steel products are now advancing in Canada as the result of wage rate increases and the general upward trend in all factors having to do with production. Imports from British mills are increasing, and practically all the galvanised sheets and much of the blue annealed are coming from Great Britain. Some Scottish pig-iron is available in the Montreal market.

The Dominion Sheet Metal Corporation, Limited, of Hamilton, Ontario, are engaged on the enlargement by 50 per cent. of the producing capacity of their plant.

There has just been incorporated at Hamilton, Ontario, the Canadian By-Products Company, Limited, with an authorised capital of $600,000, for the purpose of manufacturing firebrick, fireproof building brick and tile. They purpose erecting a modern brick plant with a daily capacity of 20,000 firebricks and miscellaneous refractories. The Company state that the manufacture of firebrick is an industry hitherto unknown in Canada, owing to the absence of known deposits of fireclay capable of being commercially exploited. They hope to supply the demand for firebricks which has hitherto been met by imports from the United States and Scotland.

A Reference.

Mr. S. G. Smith informs us that he has had several enquiries as to the issues of the Foundry Trade Journal in which his articles appeared. The one entitled Making Flanged Cylinders Without Breaking up the Brickwork appeared in February and December, 1912, the latter issue also contained his article on Cupola Practice.

Automatic & Electric Furnaces, Limited, 281-283, Gray's Inn Road, London, W.C.1, have removed to larger works and offices at the Elecfurn Works, 173-175, Farringdon Road, London, E.C.1. In order to facilitate output, the new works are equipped with improved machine tools and labour-saving devices, and demonstration rooms, with furnaces in operation, will be provided, while laboratory and industrial electric muffles will also be available for trial purposes.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands.*

By C. W. H. Holmes, B.Met. (Birtley, Durham).

(*Continued from page 246.*)

Origin and Nature of the Sands Used.

The Mansfield sand used was the variety known as "best moulding," and was obtained from the pits unmilled. Consecutive consignments of this sand have shown great regularity in grain, size, and bonds. It is typical of the best Bunter moulding sands, combining good venting properties with a fine grain and an excellent bond; also it is more refractory than many of the Bunter sands, being less micaceous. In addition, it possesses that "silky" texture which gains the confidence of the moulder, a matter of prime importance.

The Heck sand also occurs in the lower Bunter formation, but is more comparable to the Worksop deposit or to the coarser beds overlying the Mansfield "moulding sand." It is reddish-orange in colour and contains a fair amount of Muscovite.

The South Cave sand was the variety known as "South Cave Red." It is dark brown in colour and has, especially when its mechanical analysis is considered, a most remarkable bond. The peculiar stickiness of this sand is quite unique in the author's experience of English moulding sands. It is apt to be nodular and is not easy to sample accurately. Its chemical composition is sufficiently good to permit of its use as a bonding material in steel moulding. The mixture of Heck and of this sand is used, mixed with an equal amount of old sand, as a facing sand for green-sand work with great success. It occurs in the Jurassic System (Kelloway Beds).

The silica sand is a second-grade sand of unknown origin and is normally used solely in the making of "oil sand" cores.

The refractory clay used in the "silica sand and clay" mixture was obtained from the Yorkshire Amalgamated Products Limited's sand pits between Castle Howard and Huttons Ambo. These beds lie in the Lower Oolites, and the clay is found overlying well-defined beds of high-silica and kaolin-bearing silica sands of considerable purity and of widely differing mechanical characteristics. It would be more correctly classed as a strong loam than as clay. As will be seen from the bond adsorption figure, the clay grade is very "fat"; much more so than the kaolin bonding the sands beneath it. Unfortunately only sufficient was available for one test, which was made by adding the clay, ground dry, to the sand in the mill and tempering during milling. Had more been available, a second trial would have been made, adding the clay as a slip, which would probably have been more successful. In any case, the coating of smooth grains of silica with clay by mechanical means is a difficult and unsatisfactory proposition.

The Durham sand is of glacial origin. Both as considerable deposits and in isolated pockets, these sands are widely distributed in County Durham. The author has examined many samples varying from coarse bondless sands to silty loams containing up to 20 per cent. of clay grade. Whilst they appear to be quite useful from the bulk analysis, they are almost usually badly sorted as regards mechanical grading and consequently vent poorly. The bond is composed of a rather lean clay which burns out quickly, and the sand has a strong tendency to burn on to the casting. These glacial sands are widely used in the Tyne-Tees area, and their continual deficiency of bond is made good by additions of Erith or similar loam. The author believes, as regards the above district, that more defective castings are attributable to this practice than to any other single factor.

Consideration of the Result Obtained.

Amongst the new data presented in this report there is much that is difficult to interpret; there are also points upon which it is unwise to be dogmatic in view of the lack of data upon moulding sands in general. Some, however, of the results obtained afford new and quantitative data which should be of service to the ironfounder.

Examination of the mechanical analyses show a considerable and progressive degradation of grain size during the preparation of the sand. This degradation becomes more considerable when it is borne in mind that in practice the sand is milled several times during its useful life, and that the increase in grain size, which, contrary to expectation, was observed in each case after casting, must be apparent only, and due to causes which will be discussed later.

The Mansfield series (Fig. 2) is the most complete, and, as each curve is the mean of at least two elutriations, it is probably the most accurate. It is also the most easily interpreted. This sand, being fine grained, has a large surface over which

* Extracted from a Paper presented to the Iron and Steel Institute.

the bonding matter must be spread, hence it is fair to assume that this coating is thin enough to be affected almost throughout its depth before milling by the process of deflocculation, even though it may not be entirely removed from the enclosed sand grain. This contention is strongly supported by the comparatively slight increase in the bond adsorption value on milling the sand. Considerable light is thrown upon the high mechanical strength of the sand, and on the increase of strength on mechanical treatment by examination under a good hand lens × 7, and a low-power microscope × 35.

In the raw state the sand is seen to contain many clusters of grains which hold more than the average quantity of bonding material—and apparently the bulk of the fine silt as well—leaving less than the average amount for distribution over other grains; the points of contact between these latter grains being the weak link in the chain. Even after an hour's deflocculation and two hours in the elutriator, the grains retain their red tint due to a very thin pellicle of ferric oxide, which, in view of its resistance to solution in hydrochloric acid, would appear to be dehydrated and incapable of adsorbing dye.

The bond then would seem to exist in two forms:—(1) The mobile or hydrated bond which is capable of transference from grain to grain, and (2) the static bond which is fixed to the surface of the sand grains, forming a hold upon which the mobile bond may be evenly spread and displayed to the best advantage for mechanical strength. This static bond, common to all Bunter moulding sands that the writer has examined, although small in amount, certainly has a greater tendency to strengthen the sand than would a similar amount of mobile bonding material coupled with smooth grains of silica.

Alongside the grain degradation there occurs a consistent increase in the amount of clay grade separated; it is the most striking series of increases of all the grades, and is sufficiently large to be readily detected by the elutriator without the refinements adopted in this investigation. Bearing in mind that only a slight increase occurs in the bond adsorption value, it follows that practically the whole of the mobile bonding material must have been acted upon in the raw sand; consequently it would be expected to be removed in deflocculation without having to be rubbed off by the edge runner and disintegrator.

On the other hand this increase in the clay grade may have been produced by the mechanical reduction of sand to silt, and of silt to clay grade. The lower value of 1 per cent. clay grade in the prepared sand is evidence which strongly supports this latter theory.

It seems very probable that both factors have contributed an indeterminate share and also that the considerable attrition has removed a portion of the static bond, which, being of little use as mobile bond and having a low bond value, would naturally lower the value per unit of clay grade after preparation. The apparent increase in coarseness after casting is seen, on visual examination, to be due to the fritting of silt and clay around the sand grains and enlarging them. The loss of clay grade is a natural sequence of this. These aggregates are not broken down (although possibly to a small extent) by deflocculation; but treatment with hot hydrochloric acid causes separation in all but extreme cases taken from the mould faces.

The acid-cleaned silica grains from the face of the mould were opaque after casting, apparently due to internal cracking; and the bond on the uncleaned sand was bleached to a light grey, fading off through half an inch of pinkish sand to the original colour. This bleaching seems to be more of a physical than a chemical (reduction of ferric oxide) change, as the yellow ferric ions were noticeable at once on pouring acid on the sand in a test-tube. On re-milling the used sand, a fur-

Table I.—*Grade Chemical Analyses—Mansfield Sand.*

Grade.	Fine Sand.	Coarse Silt.	Clay Grade.
SiO_2	85.96	74.74	37.26
Fe_2O_3	1.24	0.94	3.44
Al_2O_3	6.26	7.28	18.32
CaO	1.54	4.23	15.58
MgO	0.90	2.47	2.10
K_2O	1.14	2.42	2.85
Na_2O	0.12	0.18	0.15
Loss on ignition	3.04	7.40	20.70
Total	100.20	99.66	100.40

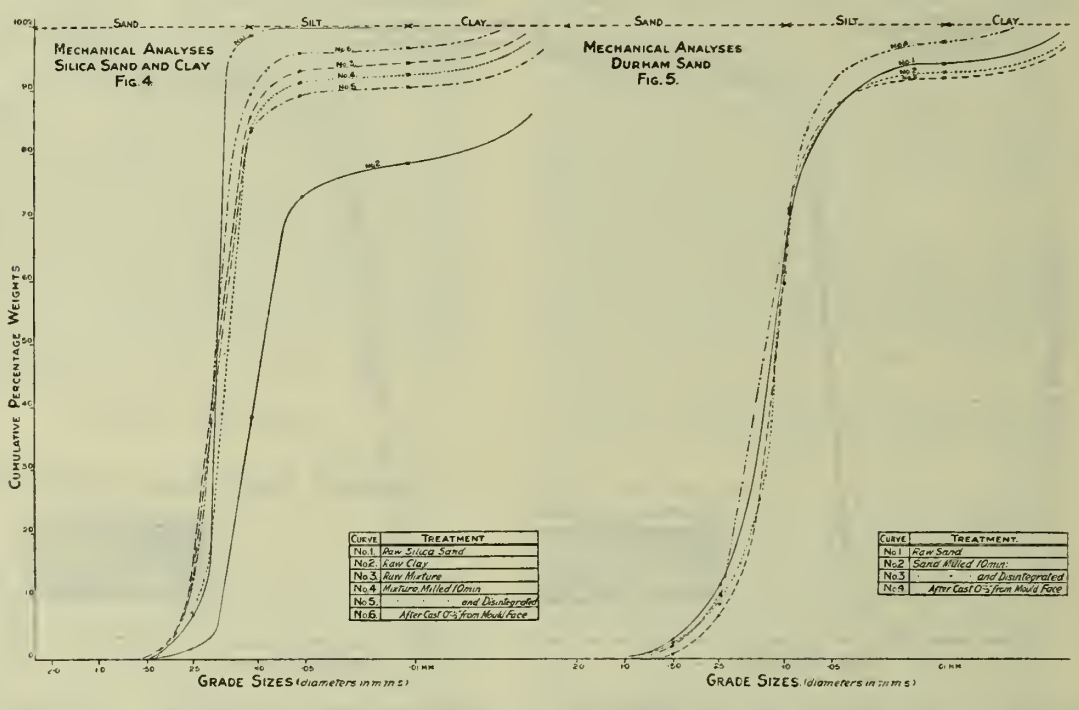

Mechanical Analyses Silica Sand and Clay Fig. 4
Mechanical Analyses Durham Sand Fig. 5.
Sand
Silt
Clay
Cumulative Percentage Weights
Grade Sizes (diameters in m m s)
Curve | Treatment
No. 1 | Raw Silica Sand
No. 2 | Raw Clay
No. 3 | Raw Mixture
No. 4 | Mixture Milled 10 min
No. 5 | " " and Disintegrated
No. 6 | After Cast O·5" from Mould Face
Curve | Treatment.
No. 1 | Raw Sand
No. 2 | Sand Milled 10 min:
No. 3 | " " and Disintegrated
No. 4 | After Cast O·5" from Mould Face

Table II.—*Grade Chemical Analyses—Heck and South Cave Sands.*

Grade	Raw S. Cave. Bulk Analysis.	Raw Heck. Bulk Analysis.	Mixture Medium Sand.	Mixture Fine Sand.	Mixture Clay Grade.
SiO_2	85.68 *	87.20	92.38	89.48	28.42
Fe_2O_3 ..	5.68	1.75	0.56	1.60	9.80
Al_2O	4.30	5.23	3.36	4.58	13.78
CaO	0.24	0.20	trace	0.66	17.20
MgO	0.26	0.28	0.20	0.34	1.41
K_2O	0.48	3.04	1.85	1.72	4.62
Na_2O	0.18		0.21	0.28	0.24
TiO_2	0.15	N.D.	N.D.	N.D.	N.D.
Loss on ignition ..	2.48	1.45	1.08	1.30	24.00
Total ..	99.45	99.15	99.64	99.97	99.47

* Professor Boswell, "Memoir on Refractory Sands," Part I. gives 0.36 per cent. P_2O^5 due to glauconite in this sand.

ther portion of the fine silt and clay grades will be removed from the silica grains, and these, together with silt grade produced by the breaking down of the cracked grains referred to above, will gradually accumulate and yield a high content of

Table III.—*Grade Analyses—Silica Sand and Refractory Clay.**

Grades.	Bulk Analysis, Silica Sand. Analysis.	Clay. Fine Sand.	Coarse Silt.	Fine Silt.	Clay Grade.
SiO_2	88.30	91.12	32.50	68.58	45.48
Fe_2O_3 ..	1.74	0.22	0.62	1.74	1.24
CaO	2.66	0.16	6.52	1.84	8.86
Al_2O_3	1.48	5.44	9.44	15.78	22.32
MgO	0.96	0.11	0.36	0.71	1.35
K_2O	0.42	1.06	1 54	2.16	3.08
Na_2O	0.35	0.31	0.47	0.38	0.44
TiO_2 † ..	N.D.	N.D.	N.D.	N.D.	N.D.
Loss on ignition ..	4.64	1.32	2.68	6.90	15.40
Total ..	100.20	99.74	98.13	97.99	98.17

* The grade analyses refer to the clay only and not to the mixture of sand and clay.
† Owing to lack of time the titanium was not determined. Professor Boswell, "Memoir on Refractory Sands," p. 136, gives 1.85 per cent. TiO_2 in a bulk analysis of this seam of clay.

silt grade, such as is almost invariably found in floor sands which have seen much service.

There is a double disadvantage involved in the use of sand of high fine high silt content: firstly, the porosity of the sand is seriously impaired, and secondly, the large surface displayed calls for a high clay content to cover it efficiently. The mixture of Heck and South Cave sands is the result of a successful attempt to imitate the good qualities of Mansfield sand in a coarser grain. In making up this mixture, South Cave sand was selected as having those properties which the writer has found to be essential in bonding materials for iron moulding sands in an unique degree, namely:—(*a*) A high content of fairly pure sand grade of considerable uniformity of grain size and possessing static bond. (*b*) A low content of silt grade. (*c*) A fairly high content of clay grade, exceedingly "fat," as shown by the dye adsorption value, of considerable permanence, as shown by the figures obtained from the "after cast" samples, and having a better chemical grade analysis than is really needed for this class of work (*vide* Mansfield clay grade). (*d*) A high content of ferric oxide, which in the writer's opinion has a very great influence upon the skin of the castings produced.

Table IV.—*Loss on Ignition per Cent.*

Sand.	Before Casting.	Distance from Mould Face after Casting. 0-½ Inch	1 Inch.	2 Inches	4 Inches
Mansfield	4.82	3.25	4.78	4.83	4.58
Heck and South Cave	2.40	1.55	2.15	2.30	2.36
Sand and clay ..	4.52	3.14	4.31	4.40	4 63
Durham	2.15	1.25	1.95	2.16	2.16

The ideal diluent for South Cave must have a very high content of sand grade of similar grain size, must possess static in preference to mobile bond, and be low in silt and clay content. It should preferably contain ferric oxide in the static bond and must, of course, be of reasonably good analysis. In this matter Mansfield sand was rejected as being too fine in grain and carrying too much coarse silt, which, harmless in the fine-grained Mansfield, where microscopic measurement has shown the bulk of the grains to lie between 0.14-in. dia. and 0.08-in. dia., would seriously impair the venting properties of a more open sand. Also the high bond carried is not needed.

Worksop sand was too fine in grain size, otherwise it would have been quite suitable. In Heck sand all the requirements are fulfilled.

Examination of the results shows that a large increase both in bond value and in mechanical strength occurs on milling and disintegration. When it is considered that the bulk of the bond is distributed, in a rather nodular state, over one-quarter of the sand, and that this has to be distributed over the remaining three-quarters, this increase is not surprising. The bond distribution factors, *id est*, strength of transverse bar multiplied by 100 and divided by the bond adsorption value, tend to show, however, that the limit of useful milling has been reached at the end of 10 minutes.

The dye adsorption values show an increase which is much more considerable than had been expected; evidently deflocculation is not violent enough to reduce the strong clay nodules to a fine state of division.

Unit clay grade shows a higher value after milling, in comparison with that before, than in any of the other sands, and this lends support to the suggestion that useful mobile bond is progressively displayed as milling proceeds, to such an extent as to overcome the diluting effect of detrital matter resulting from degradation of sand and silt. The permanence of the bond is satisfactory, though not so good as in the Mansfield sand; it would seem to be affected by temperatures below 200 deg. C. to a greater extent than the Mansfield bond, and this may be due to the South Cave bond being less ferruginous and more argillaceous than the bond in the Mansfield sand.

Table V.—*Values Shown per 1 per Cent. Clay Grade Separated in Elutriator.*

Sand	Mansfield.			Heck and South Cave.			Sand and Clay			Durham.		
Treatment	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.
Clay Grade	8.33	15.40	6.20	6.20	12.10	7.70	5.90	9.70	3.50	6.05	8.20	2.85
Transverse strength per 1 per cent. clay	11.20	11.05	19.40	15.10	34.50	10.10	—	6.50	—	6.30	6.71	5.60
Compressive strength per 1 per cent. clay	69.5	56.8	75.5	34.4	106.0	45.7	—	20.10	37.0	26.5	23.2	42.1
Bond adsorption per 1 per cent. clay ..	139.0	80.5	110.0	112.0	149.0	88.0	119.0	72.0	68.5	52.5	41.4	38.6
Loss on ignition per 1 per cent. clay ..	0.575	0.314	0.525	0.220	0.198	0.202	0.765	0.465	0.895	0.355	0.262	0.438

Table VI.—*Grade Analysis—Durham Sand.*

Grade.	Sand.	Silt.	Clay Grade.
SiO_2	94.20	80.35	50.20
Fe_2O_3	1.24	3.18	5.34
Al_2O_3	3.05	8.56	21.54
CaO	0.15	0.60	2 26
MgO	0.20	1.24	5.12
Alkalies	1.04	1.95	4.77
Loss on ignition	0.40	4.35	10.84
Total	99.88	100.23	100.06

This point is now under investigation in the Laboratory of the Birtley Iron Company.

The values obtained in the tests on the silica sand and clay mixture are not of very great value; the clay was added dry and in size smaller than 10-mesh, tempering being effected during milling; pellets of clay were present even in the disintegrated sand, giving poorer tests than should have been obtained, and rendering accurate sampling impossible.

The fact that the raw mixture was too weak to give any mechanical tests also detracts from the value of the series. The detrimental effect upon bond distribution of the lack of static bond on the smooth grains of silica is accentuated by the modified success of the series of tests. The difficulty of coating smooth silica grains with clay is, however, well known; it is remarked upon by Dr. Moldenke in his "Principles of Ironfounding," and also in a paper read before the Institution of British Foundrymen, 1919-20.

Hanley* describes the successful mixing of new well-bonded sand, old sand, and a proportion of a poorly bonded local sand, together with a small quantity of fat refractory clay. The author has

* Proceedings of the American Foundrymen's Association 1920.

also succeeded in doing this, but only in such proportions that the grains with static bond predominate.

Finally, the Durham sand is an instance of great interest, almost the opposite of the Mansfield and Heck and South Cave sands. It is a sand which, on bulk chemical analysis, appears to be an excellent one, yet this promise is not borne out in practice. The author has used a considerable quantity of a Durham glacial sand of rather better composition than the sample here investigated; it vented badly, produced an indifferent skin on the castings, and lost its bond rapidly. The facts here demonstrated go far to explain this apparent contradiction between theory and practice; on examining the bond adsorption values it is evident that the sand is bonded with a rather lean clay which is not nearly so permanent as is that of the Bunter sands.

As regards the appearance of the castings produced from the test moulds, which were not blacked nor protected in any way, the casting from the Mansfield test had an excellent smooth blue skin which was only slightly better than that obtained with the Heck and South Cave mixture. The standard clay mixture came out with a loose scale of sand and minute pellets of burnt clay, which was rather reminiscent of a steel casting from a "compo" mould.

The Durham sand gave a greyish blue skin, rather rough owing to burning on.

Whilst the refractoriness of these sands is not one of the subjects under investigation, the writer feels that it is not out of place to suggest that the ferric oxide content of moulding sands for grey-iron founding will one day, when the matter is fully investigated, be classed as a factor of prime importance. Although no evidence can be brought at the moment to support such a theory, it may be that in the presence of ferric oxide a smooth blue skin of Fe_3O_4 is formed in preference to one of high FeO content, and consequently having a smaller tendency to form ferrous silicates with the sand grains. The curve showing the maximum temperatures to which the sands were subjected is a mean curve from the four casts, the results from which were practically identical. It will be noticed that the mean point for the aluminium wire lies outside the smooth curve; this is due to its higher thermal conductivity. In the absence of a pyrometer, casting temperatures could not be determined, but would be in all cases approximately 1,250 deg. C.

Conclusions.

1. That the mechanical and physical properties of sands for grey-iron founding are of equal importance to the chemical analysis.

2. That the bond adsorption value obtained on the raw sand may be greatly modified by mechanical treatment.

3. That the most successful moulding sands contain both static and mobile bond.

4. That an appreciable degradation of the grains of a moulding sand occurs during the mechanical preparation as usually effected.

5. That the bond distribution factor is a characteristic of moulding sands that is of great importance in view of the excessive degradation which may be caused by prolonging milling beyond the time needed to effect the optimum distribution.

6. That no single test is sufficient on which to judge the practical value of many moulding sands, but a careful consideration of all those tests which have been described above.

The writer wishes to thank Mr. K. C. Appleyard, General Manager of The Birtley Iron Company, for having readily granted every possible facility for the conduct of this research. Also Mr. J. Brewis, Works Manager, for his ready assistance in many details.

Boron as a Steel Alloy.—Experimental work performed by the U.S. Bureau of Mines indicates that the use of boron as an alloy confers marked hardness on steel. If the other physical properties of the boron steels are good enough to be applicable to commercial use their remarkable plasticity at temperatures below the melting points of ordinary steels might make it possible to utilise this characteristic.

The Institute of Metals.

Discussion on White Metals.*

Sir Henry Fowler, K.B.E., in opening the discussion, said that some time ago, at the instigation of Mr. Weeks, he looked very carefully into the question of various white-metal alloys used for locomotive purposes. He was under the impression that the alloy which was very largely used in the aeronautical work was not that given in paragraph No. 1, but that it approximated more closely that given in paragraph No. 2, namely, 85 per cent. tin, 10 per cent. antimony, and 5 per cent. copper, with the Brinell hardness as stated in the Paper. That was a metal which had been very highly spoken of by a French observer as being one of the best metals in existence. One point in locomotive work and motor car work which was of very great importance had been accentuated in the Paper, namely, the question of whether a metal was being used which was simply a bearing metal, or one which was resistant to alternating pressure. It was necessary in all reciprocating engines to have a metal which would not spread when it received a blow, and the metal with the composition of 85:10:5 was used almost universally for locomotive purposes, and for other engine purposes where repetition stresses occurred. The great difficulty existed in locomotive and motor-car work of getting a considerable pressure. Although some of his colleagues on other railways used a metal which approximated very closely to that given in paragraph No. 5, namely, tin 60, antimony 10, copper 2, and lead 28, a close investigation had not led to some of the other railways, which would like to use that type of metal, adopting it, owing to the fact that they were not able to get quite as low a pressure owing to the gauge and other reasons as those who used it satisfactorily. A third metal was used very extensively on railways, but no reference was made to it in the Paper. It approximated to alloy No. 7—tin 12, antimony 13, lead 75—and it had a Brinell hardness considerably lower than the figure stated. If there were any changes of stress that was a very satisfactory metal to use; indeed, it was very extensively used at the present moment. The author referred to the use of a metal similar to No. 9 on Continental railways, particularly in Central Europe, but he was surprised to find that the Brinell hardness of that metal was about 25. He had the opportunity since the war of seeing certain of the metals in use on the Continental railways, and personally he would have said that the Brinell hardness figure was lower than that stated in the Paper. He desired, in conclusion, to refer to the question of the eutectic providing a space in which oil lie. He knew, from experience obtained fifteen or eighteen years ago, that trouble was caused in certain cases. Owing to the conditions under which the metal containing 85 per cent. tin was cast, cuboid crystals stood high, the eutectic melted away, and great trouble was caused with hot bearings. That was entirely due to the temperature. He desired to emphasise the point that had been made, not only at the present but at other meetings of the Institution, that the one thing it was necessary to deal with from the works standpoint was the question of temperature control. It was necessary constantly to press home that point upon those responsible, because it applied not only to white metals, but to other metals as well. When pouring out of a ladle difficulty occurred in obtaining that temperature control which meant so much in obtaining a satisfactory white-metal bearing.

The Author's Reply.

Mr. A. H. Mundey, in reply, said the author quite expected to be taken to task at the attempt at theorisation they had made with regard to the cause of the distribution of the oil film due to the irregularity of the structure. Sir Henry Fowler had expressed surprise that the authors should have stated that No. 1 was the bearing metal which was commonly used in aero-engines. Perhaps the authors had over-stressed the point by saying that No. 1 metal was chiefly used, but certainly that metal was largely used on certain engines which gave a vast amount of trouble, and that point was very much impressed upon them. Personally, he was responsible for giving the matter undue prominence.

* This Paper appeared in our last issue

Turbine Steam Chest Troubles.

By S. G. Smith.

The castings entering into this category are numerous, and include turbine-engine parts, condensers, coolers, gas and oil engines, also air and vacuum castings.

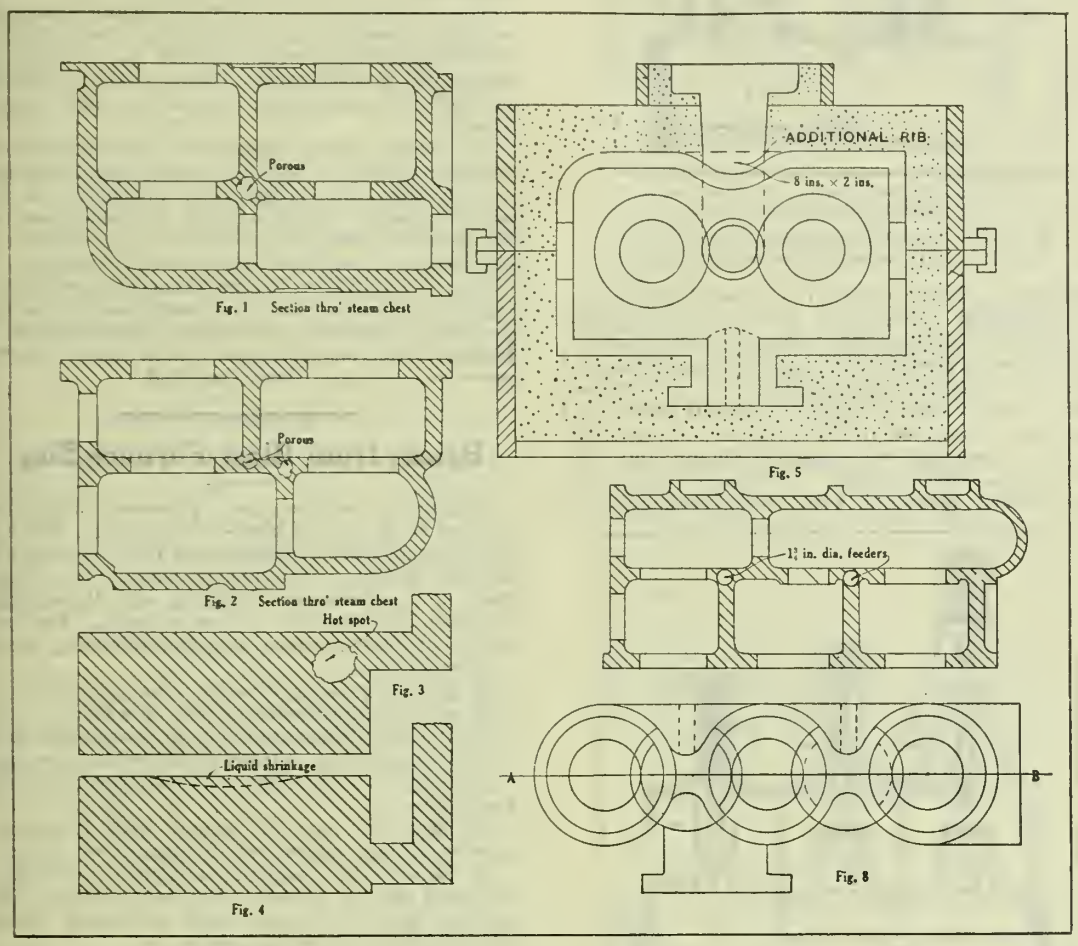
Steam Chest for Rateau-Impulse Turbine.

Steam chests for turbines are made in both iron and steel, and vary in weight from 10 to 50 cwts. The water test applied ranges between 250 and 500lbs. per sq. in. Steel shows one advantage, being weldable, whereas cast iron does not readily lend itself to this treatment, despite what has been said to the contrary. Very often a bad steel steam chest can be made good by welding, whereas a very slight defect in an iron casting will scrap it. Although a steel steam chest can be welded, large numbers are so porous that even welding fails to make them water-tight.

chests were suggested, but this presented too many engineering difficulties, hence no other course was open but to persevere in the foundry.

One of the worst features about these castings was that all machinery, boring, drilling, and threading were completed before the testing could be carried out, which would mean that all labour and time spent upon these operations were lost if the casting failed; this often happened, and was a very serious loss of time and labour. The porous places were chiefly found at the junctions of the internal partition walls. When this occurred it did not admit of being easily cured, consequently the casting was usually scrapped.

Figs. 1 and 2 give the location of the porous places. It was quite natural for these to exist just where they are, seeing that the liquid iron at the junctions of the internal partitions was completely



Defects.

The defects in both steel and iron steam chests are often situated in the same places. This is not surprising, as the trouble in either case arises from liquid shrinkage, which shows up during the pressure test.

As a rule, when properly moulded, and poured with a good-quality iron at a fairly high temperature, the large steam chests give the least trouble, and a waster in the foundry or machine shop is rare. It is the small, chubby, heavy section steam chest that gives most trouble under water pressure test, and it is to these particular chests that these remarks refer.

These chubby steam chests, which each weigh from 10 to 15 cwt. when cast, have four partitions, or part-partitions when moulded. Four separate water-test pressures are applied, one in each of three chambers and one for the whole of the outside section; this means that not an inch of internal or external surface escapes water pressure, and in each case under observation.

Alteration in the design of these particular enclosed within a circle of liquid metal, comprising the outside walls, thus the thick sections of the internal partition walls would be much longer in the liquid state than the surrounding walls, hence the inevitable drawing away from the parts that were longest in the liquid state, in other words, the parts that were last to solidify.

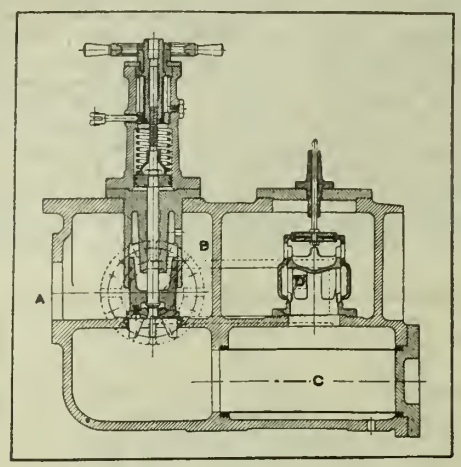
The problem was how to obtain the soundness required at these junctions under such circumstances.

There are several conditions which contribute to porous and open places in an iron casting, amongst which are the following:—The hottest spot or area in a casting is a place liable to be porous. It does not always follow that this is the thickest section of a casting, although in many cases this is so. It is an accepted rule that the heavy places require feeding. To illustrate this take a small plain casting of equal dimensions; if the ingate is at the top in all probability the drawn place will be quite near to it, as shown in Fig. 3. Now if the ingate was situated at the bottom, as in Fig. 4, the hot spot or area would be rendered

sound by static pressure. If one could always control the porous places by altering the position of the ingate runner they would soon disappear. Unfortunately this cannot be done. Another place where porosity is apt to occur is at thick and thin places when in close proximity. Also there is a possibility of porosity existing due to the phosphorus eutectic; each of these aspects will be discussed as certain castings are being dealt with.

Steam Chest.

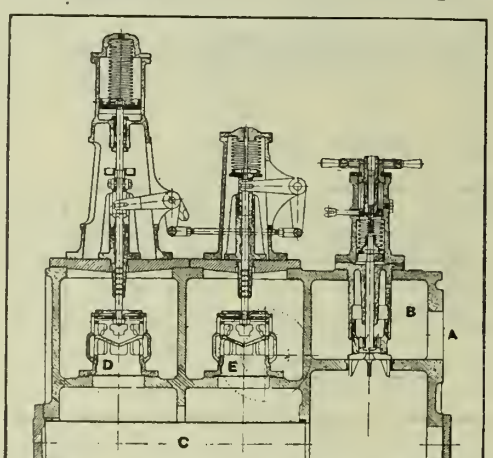
Reverting back to the steam chest, in order that the external shape of the pattern should not be



A=Entrance for steam. B=Stop valve. C=Strainer. D=Governor valve.

Fig. 6.—Section through Steam Chest for Small Turbine, Sketched in Fig. 1.

altered, the writer resorted to several devices for its prevention. Chills, for instance, were applied at various places on the outside of the pattern, and also were placed in the core boxes and rammed into the cores at the junctions of the internal walls. They were also made in various shapes and cast into the section of the metal at the junctions. In fact, denseners were applied, many and few, both inside and outside. Although the moulds were almost plastered with them, leakages still



A=Connection for steam pipe. B=Stop valve. C=Strainer. D=Main governor valve. E=Automatic overload valve.

Fig. 7.—Section through Steam Chest for Medium Turbine.

occurred under water test. Feeders as large as practical to the contour of the pattern were tried but to no avail. The castings were poured at high, medium, and low temperatures with the same result. Also the mixture and analysis of the iron was varied, but with little or no improvement. The static pressure put on the mould when pouring by increased height of the runners and feeders was almost enough to burst the moulding box; these and other methods were tried, but a satisfactory permanent result was not obtained. As a last resource, and without any internal alteration design and no material alteration externally, a thick rib was added to the pattern immediately opposite and above the internal junctions which were porous. The distance between the additional rib and the porous places would be about 10 in. This rib, the thickness of which was 2½ in. and the length about 8 in., completely covered the internal junctions. Above this a specially large feeding riser was fixed, the thickness and length of which would be a little less than the rib. A large feeding head or reservoir was provided above the feeder. The dimensions of the feeding rib, riser, and head were such that two ½-in. round feeding rods could be worked at the same time which passed right through the chamber walls and junctions, a depth of 24 in. from the feeding head. With the addition of hot feeding iron both feeding rods were working for twenty minutes; thus the feeding mass kept alive and liquid as long as the internal area that enclosed the porous junctions.

This method, when properly and intelligently carried out, effected a cure every time, and the records showed that 18 succeeding castings were perfectly sound and exhibited no sign of defect when under water test. The length of time that the interior remained in the liquid state was a revelation.

The design of the pattern being unaltered neither internally nor externally, the additional rib for feeding purposes could be drilled and taken off if necessary. The contour of the top half of the pattern as poured was only slightly altered.

The writer, during his career, has tackled many foundry problems, but no casting has given more anxiety than this design of steam chest. So long as this design of steam chest is made there will be trouble under the pressure test unless all precautions mentioned are strictly observed.

Fig. 7 emphasises the importance that the seatings of the valves, and the partitions of the compartments, should be absolutely proof against any leakage from one into the other; hence the four pressure tests are always applied.

Bricks from Blast-Furnace Slag.

Numerous devices and processes have been devised to dispose of blast-furnace slag. However, most methods are expensive and fail to produce the desired results. The idea presented in a recent issue of the American "Mining and Metallurgy" has been protected by recent patents. For utilisation of blast-furnace slag the following scheme is proposed:—

(1) Discharge slag directly from furnace into cars, which contain several feet of water.

(2) Place disintegrated slag in centrifugal drier.

(3) Run product through pulveriser, crushing slag so that 75 per cent. will pass through a 100-mesh sieve.

(4) Mix one part of cement with 12 parts of powdered slag, adding small amount of water.

(5) Mould the resulting mixture in bricks of standard size, in presses. Bricks made from blast-furnace slag have been tested at Lehigh University with the following results:—

Transverse Test.—Support ⅛ in. from each end. Width 2 5-16 in., depth 4 in. Span 7 in. Average breaking load, 7,000 lbs.

Compression Test.—Bricks were set on edge, after being broken in half. The following area was subjected to compression: Length 4 3-16 in., breadth 2 5-16 in. Average breaking load, 80,000 lbs., or ultimate strength of 8,500 lbs. per sq. in.

Absorption Test.—In a period of 11 days the bricks absorbed 7.15 per cent. of their weight in moisture.

Shearing Test.—When subjected to a double shearing test they failed at unit load of 1,650 lbs. per sq. in.

These tests show that bricks made from blast-furnace slag have a strength far above the average made from shale or clay. The texture of the bricks is uniform, and an even, smooth surface results from the described method of manufacture. The cost is far less than that of making bricks from clay or shale, as the whole process can be operated in conjunction with the blast furnaces of any iron and steel plant.

The Boom of the German Iron Market.

The Commercial Secretary at Cologne has forwarded the following extract from the "Frankfurter Zeitung" for September 12:—

The month of August saw the failure of the London negotiations and the consequent fall of the mark, with its many fluctuations, under which impression the demand for the products of the heavy industry remained extraordinarily brisk, trade and consumers endeavouring to cover their requirements before a further increase set in. The demand was therefore great, the only exception being thick plate, which was no doubt due to the lack of employment on the wharves. In bar iron, sections, middle and thin plate on the contrary everything available was bought. The extraordinary demand which is asserting itself is to be attributed to the separation of the Upper Silesian Works and the irregular working at the present time of that industry, and the consequence will certainly be that large quantities of bar iron will be imported from the Saar district, Luxemburg and Lorraine. This danger is all the greater as the difficulties of production have not improved. The works are suffering continually from an insufficient coke supply and a shortage of workers, so that great difficulty is experienced in keeping to terms of delivery.

The demand from abroad was in general satisfactory, especially in thin and middle plate. Prices, however, show a downward trend. Belgian competition was very much felt, as was also English competition, especially as England delivers more punctually. The tremendous new price increases were met with great hostility by the public. The Minister of Economics was of the opinion that the time had come to intervene with coercive measures in the iron industry. During the negotiations at the Eisenwirtschaftsbund the representatives of manufacturers, consumers and trade were, however, successful in persuading at least a part of the employees that the re-introduction of maximum prices would at the present time be the worst and, from an economic point of view, the most harmful measure possible. The re-introduction was rejected by 24 votes to 12. With the increased monetary requirements for purchases and other reasons, the inevitable want of working capital is likely to restrict greatly business activity even if it does not lead to unemployment. The same reasons will prevent the finishing or the new building of business premises and dwelling houses. Anxiety is growing in regard to the prospects of continuing to find employment for the many thousands of people employed in the iron industry. Foreign competition notes with satisfaction the German price increase. In these circumstances it is impossible to keep up export trade against foreign competition which—with the help of German coal—is disputing the market to Germany. But of far more importance is the fact that, in view of prices and the short terms of delivery, foreign competition is being felt in Germany itself. This is all the consequence of the great German coal shortage. The ore deliveries continued to suffer on account of the shippers' strike in Holland, which had not come to an end. Owing to the tremendous mark depreciation, the demand for inland ores was very brisk and could not be satisfied, especially as during the first part of the month the ore deliveries, particularly in Siegerland, suffered from a truck shortage. In foreign ores business was dull, the smelting works keeping aloof owing to the fall of the mark and the shortage of coke and money. No business transactions worth mentioning were concluded either in Swedish or Spanish ores. Vabana ores are being supplied regularly and satisfactorily. Contracts were made recently for the current year at the price of 18s. 3d. c.i.f. Rotterdam on the former basis. Further negotiations are pending in regard to new contracts in Vabana ores for delivery in 1923. New contracts in Lorraine minette were concluded with the Syndicate for delivery until the end of the year, but the quantities in question are far smaller than those for the third quarter. Prices are quoted 25 cts. more than last contracts, amounting to Fr. 11.75 c.i.f. Gr. Mövern, or Fr. 12.50 c.i.f. Algringen. Briey minette has been offered a great deal of late both by the Syndicate as well as by dealers at Fr. 14.50 c.i.f. Conflans, or Fr. 21.50 ex frontier on the basis 35 per cent. iron. On the manganese ore market offers were scarce and prices steady. Prices on the scrap market followed the foreign bill market. Heavy scrap increased to 15,000 Mks. Turnovers were, however, small, as consumers and dealers held aloof on account of the uncertainty of economic conditions.

The pig-iron market remained very strained. The inland demand could not be fully met in most kinds of pig-iron, so that the Pig-Iron Association saw itself forced, in spite of the unfavourable exchange, to import foreign supplies. The demand for semi-manufactures was very brisk, as, in view of the development of the exchange, supplies of foreign semi-manufactures were out of the question. Requirements were therefore not always met. A great shortage was to be observed in material for railway tracks, and the demand of the Railway Central Office, as well as that of private sources, could not be fully satisfied. Requirements in rails for mines and sleepers were only covered in part. The supplies of sections were unsatisfactory. The decline in employment in railway rolling stock observed last month showed no signs of improvement, the chief reason being that the State Railway administration is holding back with the distribution of orders. In bar iron and hoop iron the works are fully occupied, and the orders on hand guarantee employment for the next few months. Export business was dull, no large contracts being concluded. In thin plate inland trade was very brisk, but no exports took place. Thin and middle plate were very much in demand, but there were but few inquiries for thick plate. Cast-iron pipes were very much sought after, there being many inquiries from abroad. On the wire market the demand for wire rod was as great as last month.

Contracts Open.

Newton Abbot.—New or second-hand 6-in. and 9-in. cast-iron pipes, for the Newton Abbot Rural District Council. Mr. S. Olver, highway surveyor, 9, Marlborough Terrace, Bovey Tracey.

London, S.E., October 6.—Shovels, etc., for the High Commissioner for India, viz., 8,004 shovels, round nose, with handles; and 3,000 shovels, stoking, with handles; 2,500 cocks, bib, galvanised, ½ in. and ¾ in.; and 1,634 cocks, stop, galvanised, ¾ in. to 4½ in.; (3) 45,000 ft. point rodding, 1¼ in., solid, complete with bolts and nuts. The Director-General, India Store Department, Belvedere Road, Lambeth, S.E.1.

Deaths.

Mr. F. W. Ballard, ironfounder, of Abingdon, died recently at the age of 63.

Mr. W. Hexter, a director of the South-Western Brass Foundry, Limited, Plymouth, died recently at the age of 71.

Sir Richard Martin, a director of the Swansea Vale Spelter Company, Limited, died on September 16 at the age of 79. The deceased gentleman was born at Pentremawr, Swansea, in 1843, and was first employed at the Millbrook Iron Works. In 1867 he entered H.M. Customs at Swansea as a clerk, was transferred to Grimsby, but three years later he returned to Swansea and commenced in business on his own account. In 1879 he joined a few friends in the establishment of the Swansea Vale Spelter Works at Llansamlet (with which he maintained an association to the end), and in 1881 he established a steelworks at Birchgrove, and in 1884 the company of which he was managing director acquired the Ynispenllwch Tinplate Works. His association with industry continued to the end, but the only works he was in his later years actively connected with was the Swansea Vale Spelter Works.

J. Blakeborough & Sons, Limited, of Brighouse, Yorkshire, have amalgamated their business with that of George Kent, Limited, 199, High Holborn, London, W.C.1.

Trade Talk.

Mr. R. Hutcheson has removed to 2, Mair Street, Plantation, Glasgow.

Beecroft & Partners, Limited, have removed to St. Peter's Close, Sheffield.

Mr. H. F. Barton, metal trade valuer, has removed to 39, Albion Place, Sittingbourne Road, Maidstone.

The Ironclad Switchgear Company, Limited, have removed their London offices to 23, Queen Anne's Gate, Westminster, S.W.1.

Shand, Mason & Company, fire engine manufacturers, etc., are retiring from business, the goodwill of which is to be sold.

Alexander Stephens & Sons, Limited, Linthouse, Govan, Glasgow, have secured a contract for a new steamer of 6,000 tons for Elders & Fyffes, Limited, Glasgow.

As a result of a decision that the furnaces at the Elba Steelworks, Gowerton, should not be lit last week 200 men employed in the melting shops are out of employment.

Mr. H P. Allen, late of Burton, Griffiths & Company, Limited, has taken over the representation of Bell's United Asbestos Company, Limited, in Leeds and North Lancashire.

Alfred Herbert, Limited, have taken over the agency of the Cleveland Automatic Machine Company, Cleveland, Ohio, U.S.A., for the Cleveland automatic screw and forming machines.

In consequence of the Ebbw Vale Steel, Iron & Coal Company's works in Wales being stopped by a wages dispute, the five hundred employés at the firm's Irthlingborough (Northamptonshire) mines received a week's notice on Friday last.

Piecework price rates were the cause of a dispute at the shipyard of Chas. Connell & Company, Limited, Scotstoun, as a result of which some frame squads are on strike. Only a small number of riveters are involved, but the strike has thrown a good many helpers out of work.

Messrs. J. C. Bishop and O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, announce the result of the audit for July and August. This certifies the average net selling price as £11 0s. 7.25d., with a decrease in the wages of the workmen of 2½ per cent., on basis rates.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to H. Bath & Son, Limited, 53, New Broad Street, London, E.C.2; R. B. Bethell & Company, Limited, 29, Exchange Chambers, Liverpool; E. M. Boundy, 15, New Street, Bishopsgate, London, E.C.2; and E. Eastwood, Dolphin Place, Ardwick Green, Higher Ardwick, Manchester.

We regret that, in consequence of a printer's error, we stated in our last issue that the English Electric Company, Limited, were closing their works. The correct wording should have been "their Coventry works." We are informed by the company that this decision was arrived at owing to continued trade depression and the dearth of export orders, and that they propose to concentrate production in their four other works at Preston, Bradford, Stafford and Rugby.

In connection with the South Wales and Monmouthshire iron and steelworkers' sliding-scale, the joint auditors' report for the three months ended August 31, 1922, shows that the average net selling price of steel rails (20 lb. per yard and upwards) and steel tin bars is lower than in the previous quarter to the extent of over 9s. per ton. The sliding scale will, therefore, fall 4½ per cent. as and from October 1—that is, from 55½ to 51 per cent. above standard, which will be the ruling percentage to December 31 of this year.

Belliss & Morcom, Limited, Ledsam Street Works, Birmingham, have sets of lantern slides, each consisting of twenty slides with a booklet of descriptive matter, which they will supply on loan free of charge for lecture purposes. These slides include quick-revolution engines with forced lubrication, and the production of power at low cost in conjunction with heating and drying by exhaust steam.

The Stamped or Pressed Metal Wares Trade Board have sent notification to the Minister of Labour that, after considering all objections lodged with them, they have varied the minimum rates of wages for certain classes of skilled male workers, in accordance with the provisions of their notice dated June 21 last. The Minister is asked to confirm the rates as varied, and to bring them into operation on October 14. The new minimum rates are based on a sliding scale according to the cost of living index figure.

Mr. M. R. Lawrence, works manager of the Sterling Telephone and Electric Company, Limited, Dagenham, Essex, has been re-elected as president of the Institution of Production Engineers for the 1922-1923 session. During February a paper on "Machine Moulding Methods" will be read by Mr. F. T. Hardyman, foundry manager to Petters, Limited, Yeovil. Local branches of the Institution have already been formed at Coventry and Newark-on-Trent, and it is hoped to inaugurate a local section at Glasgow during the coming session.

An agreement was reached on Wednesday between the Negotiating Committee of the Railway Managers' and the Trade Unions with respect to the war wage of workmen employed in the railway shops. Under the terms of the agreement the war wage of 26s. 6d. per week will be reduced from October 2 by 10s. per week, and wages will be stabilised on this basis until December 31. The settlement, which has been effected by the parties, gives an advantage of 6s. 6d. per week to the craftsmen and unskilled workers in railway shops as compared with the men employed in general engineering establishments.

On October 10 the representatives of the Engineering and Shipbuilding Trades' Federation are to meet the shipbuilders and announce the Federation's attitude towards the proposal made by the masters that the remaining 10s. of the 26s. 6d. war bonus shall be discontinued as from November 1. The employers propose that this shall apply to all but the lower paid men, and, conditional upon its acceptance, have expressed a willingness to agree to a period of stability during which there will be no further national general fluctuations. So far as the lower paid men are concerned, the absorption of the remaining war bonus shall be applied at intervals and to an extent justified by a scale the employers are willing to discuss with the labourers' Unions, but reductions below 37s. 6d. per week are not likely to be proposed from the masters' side. At the moment the Federation is taking a ballot of its members on the proposals.

Company News.

Furness, Withy & Company, Limited.—Half-yearly ordinary dividend, 5 per cent. per annum, free of tax.

Midland Electric Corporation for Power Distribution, Limited.—Interim ordinary dividend, 8 per cent. per annum, less tax.

Star Engineering Company, Limited.—Dividend on preference and ordinary passed; debit balance, £5,590, carried forward.

Jackson-Rigby Engineering Company, Limited.—Capital £3,000. Directors: A. G. B. Chaldecott, S. Jackson and H. Greenly.

Arthur G. Foulds, Limited, Dunedin Street, Edinburgh.—Engineers. Capital £20,000 in £1 shares. Directors: A. G. Foulds and E. E. Chalmers.

Ajax Production Engineers, Limited, 188-189, Strand, W.C.2.—Capital £3,000 in £1 shares (1,500 ordinary and 1,500 7 per cent. cumulative preferred. Secretary: H. J. Bellingham.

Partington Steel & Iron Company, Limited.—Net profit, £10,389; interest, £85,978; brought in, £34,717; dividends on preference shares, £21,000; ordinary dividend passed; carried forward, £24,106.

Galpin & Coulton, Limited, 43 and 49, Gunnersbury Lane, Acton.—Engineers. Capital £7,500, in 7,200 8 per cent. cumulative preferred ordinary of £1 and 6,000 deferred shares of 1s. Director: C. T. Galpin.

Watson Lister, Limited, Ashburton Road, Trafford Park, Manchester.—Engineers. Capital £10,000 in £1 shares (8,000 cumulative participating preferred and 2,000 ordinary). Directors: W. W. Lister, C. J. Hobson and A. J. Adams.

Mahler & Company, Limited, 705-709, Royal Liver Buildings, Liverpool.—Capital £20,000. Manufacturers, importers and exporters of and dealers in iron, steel, metals, minerals, etc. Directors: W. H. Jones, W. D. Peet, and A. A. Travers.

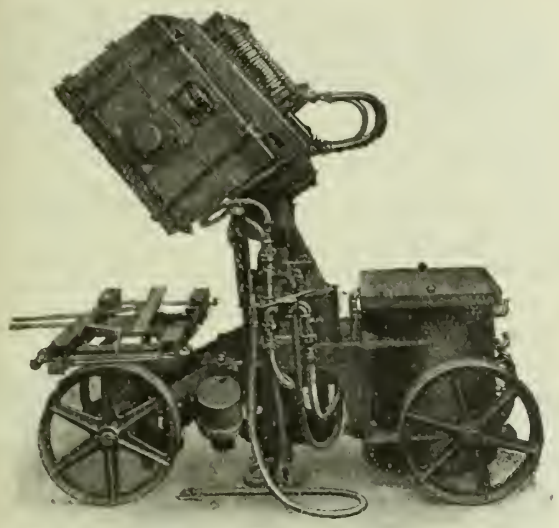
Dobson & Barlow, Limited.—Profit, £266,512; brought forward, £20,878; available, £287,390; final dividend on ordinary, 20 per cent. per annum, making 20 per cent. for year; bonus, 2s. per share, tax free; reserve, £135,000; carried forward, £67,890.

Thompson Engineering Company, Limited.—Capital £3,000 in £1 shares, to acquire the business carried on by J. Thompson at Haddrick's Mill Ridge, South Gosforth, Northumberland, as the Thompson's Engineering Company. Director: J. Thompson.

Thomas W. Ward, Limited.—Preparation of two years' balance-sheet postponed pending settlement re excess profits duty. Quarterly dividends, 5 per cent. per annum on first and second preference and employés' shares; dividend 10 per cent., free of tax, paid for year to June, 1921.

Dalmellington Iron Company, Limited.—Profit, £35,601; brought forward, £7,577; total, £42,978; depreciation, etc., £15,953; preference dividend, £6,500; interim ordinary dividend, £6,825; final dividend, 6d. per share, free of tax, making 5 per cent. for year; carry forward, £6,874.

MACNAB & CO.



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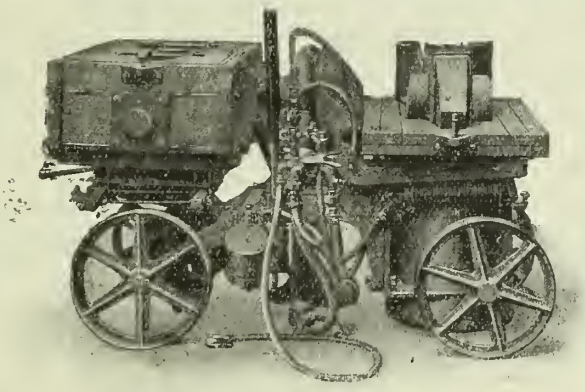

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IRON AND STEEL MARKETS.

Pig-iron.

The opening of the final quarter of the year's trading gives, at present, faint promise of stable improvement in the pig-iron industry, which, although to some extent better than in the corresponding period of 1921, still leaves much to be desired in the volume of business transacted. This may be specially noted in the case of the South Staffordshire area, where the production of iron is still restricted to unimportant hand-to-mouth deliveries, barely sufficient to keep the limited number of furnaces now in blast in operation. Smelters in this district (as in others) are considerably handicapped by the continued high cost of production, which precludes the possibility of reducing prices, and in some instances furnaces are even said to be working at a loss. Consequently prices in the Midland market retain their firmness, with quotations, as given on another page, unaltered. The Glasgow pig-iron market has been a little quieter of late, the demand from America being easier—at least, as far as Scotch iron is concerned. Inquiries and orders are, however, still coming in for English and Continental irons, and there is now a strong feeling that the American demand for Scotch iron is by no means exhausted. Early this month two boats, taking about 1,100 tons between them, are due to leave Clydeside for Philadelphia and Boston, and in addition there are some heavy shipments coming on for other ports. On Tees-side the market for Cleveland iron maintains its hopeful tone, the timely American buying of the last few weeks having largely relieved the depression previously prevailing in the trade. At last week's markets, inquiries in good volume were still circularised from the United States and Canada, and it is quite anticipated that this demand will continue for some time, though perhaps in diminishing amount, despite the new tariff now in force in American ports. The pressure for export has substantially improved the demand for Cleveland iron from Scotland, where, with stocks diminishing, prices have risen well above Middlesbrough levels. The home market generally also is better, consumers having apparently made up their minds that it is useless to wait for more favourable terms. On the other hand, Midland iron is again offering at lower rates, although the quantities available are but limited. At the moment, however, makers are well sold over both October and November. In the circumstances, 95s. for prompt No. 3 is more or less nominal, but business can be done for October delivery at 92s. 6d. No. 4 foundry is firm at 90s., and No. 4 forge is obtainable at round about 85s., with mottled and white about 80s. per ton. Continental demand is very quiet.

The hematite trade continues to improve. Good sales to South Wales are reported, and business has also been done with Scotland. As regards exports, Belgium is a steady buyer, but the Continental trade generally is very patchy. Germany is still out of the market, and Italy is only taking moderate lots. Still, on the whole the volume of trade is distinctly better, and during the last week or two stocks are reported to have been substantially reduced. Quotations are correspondingly firmer, makers now demanding 90s. for East Coast mixed numbers, with a premium of 6d. per ton for the No. 1 quality. In Cumberland and North Lancashire there is a slight firming up of prices, and Bessemer mixed numbers this week are quoted for export at £5 per ton to £5 2s. 6d. per ton.

Finished Iron.

Conditions in the various sections of the finished-iron trade continue unsatisfactory, the recent renewal of aetive foreign competition having considerably complicated an already difficult position. This will be better realised from the fact that offers are reported in the home markets of bars of Continental origin at prices from 25s. to 30s. less than those Midland manufacturers are quoting, and it is stated that the delivery period is now less difficult than it was. South Staffordshire makers find it quite impossible to compete with such priees, claiming that when there is any profit on the iron produced it is far less than 25s., and so producers are compelled to remain idle and see these orders go abroad. Doubtless this and other matters of vital importanee to manufacturers will come up for serious discussion at the forthcoming quarterly meeting, when it is suggested in some quarters that representations should be made to the Government with a view to discovering why it is that the foreigner can offer iron at so very much less than the price at which it can be produced in the principal seat of manufacture in this country. Of course, it is the commoner irons that are directly affected by this competition. Manufacturers of marked and other good-class quality bars are not so much affected by imported material, but even in that case the selling prices of their products are declared to be barely profitable, while the demand continues on a very restricted scale. The heavy cost of production explains the remarkable range of quotations for unmarked bars, and between unmarked and marked the width of the range being an indication of the peculiar conditions prevailing. There must always be a range in prices in South Staffordshire bars owing to the corresponding range in quality, but a margin of about £3 between the bottom and the top is an abnormality probably without precedent.

Steel.

Current business in steel continues on a slowly-improving scale, some districts, however, showing more expansion than others, but in the chief centre of the industry, Sheffield, demand is chiefly confined to the less expensive grades of material, the crucible quality of metal especially being exceptionally quiet. The passing by the American Senate of the Fordney Tariff Bill is a big set-back for many British manufacturers, and it remains to be seen whether rate of exchange differences between the two countries, possibly brought about by the Bill, will later re-act in such a manner as to allow English exporters to again re-enter the American market. The quick passing of the Bill has apparently caught some of the importers, and reports are current of several vessels packed with all classes of dutiable goods arriving a day or so late. As an indication of the general conditions in the home trade may be noted slightly increased activity in demand for ferro-alloys, silico-manganese being in a little better inquiry, as well as ferro-phosphorus, while the price of ferro-silicon has eased off a little in 45 per cent. grade by reason of Exchange differences, and only a moderate amount of business is passing. On the North-East Coast there is certainly more work coming forward at the steelworks, and the better feeling now in evidence will no doubt be further improved by the recent indications of some movement in the shipbuilding industry. Good inquiries for new tonnage have come to hand, and if these eventuate in orders to the local shipyards the steel trade will be correspondingly stimulated. Notwithstanding the recent improvement in trade, the steelworks of Messrs. Bolckow, Vaughan & Company, Limited, and of the Skinningrove Iron Company, Limited, still remain idle. There is no change in prices. Conditions in the tinplate market continue quiet, and the outlook by no means reassuring, while the present output is exceeding the demand. Making for stock, of course, cannot go on indefinitely, and unless a considerable improvement is shortly effected there is a prospect of many of the mills closing for want of orders. The general tone of the market is not good, and prices are "sagging" all round. So far as the basis sizes are concerned, 19s. has been accepted for spot delivery, but for October onwards 18s. 6d. has been taken, and there are now more sellers than buyers at the price. Current quotations:—Coke tins, IC 14 x 20, 112 sheets. 108 lbs., 18s. 6d. to 19s. per box; IC 28 x 20, 112 sheets, 216 lbs., 38s. 3d. to 39s. per box; lights and crosses at usual differences, net cash, f.o.b. Wales.

Scrap.

The partial improvement in the pig-iron trade recorded above is to some extent reflected in some markets for scrap material, and on Tees-side, where the works are buying a little more freely, 65s. per ton is readily paid for heavy steel scrap, of which there is a decided shortage. Heavy steel turnings and cast-iron borings are also in better demand, and with both descriptions scarce the price has hardened to round about 52s. 6d. per ton. There is a little more interest being taken in cast-iron scrap, moderate parcels of good machinery quality making from 72s. 6d. to 73s. 6d. per ton. The ordinary heavy qualities are offered at about 70s. per ton. There is a fair demand for burnt metal, for which about 55s. per ton is being paid. There is no demand at all for heavy wrought-iron scrap, the nominal prices for which are: Bushelling, 55s.; ordinary heavy piling, 60s.; special heavy forge, 70s. to 75s. per ton. All these prices are delivered works. At Glasgow, on the other hand, there has been somewhat of reduction in the quantities of steel scrap which have changed hands. This is accounted for by the unwillingness of consumers to pay 72s. 6d., and few sellers are disposed to cut their price unless for small odd lots for immediate delivery. The majority of the works are, however, in the market for supplies.

Metals.

Copper.—Movements in base metals during the past week have inclined to an appreciation of values, standard copper especially indicating a firmer tendency. The recent weakness in the copper market has been unquestionably induced by the critical position in the Near East, but it is not anticipated that the adverse conditions will continue for any length of time. The rate of domestic consumption is, however, steadily maintained, and in the United States shows a substantial increase, due to the termination of labour troubles on that side. Current quotations :—*Cash* : Wednesday, £63 7s. 6d. ; Thursday, £63 12s. 6d. ; Friday, £63 17s. 6d. ; Monday, £63 12s. 6d. ; Tuesday, £63 10s. *Three Months* : Wednesday, £63 17s. 6d. ; Thursday, £64 5s. ; Friday, £64 7s. 6d. ; Monday, £64 5s. ; Tuesday, £64 2s. 6d.

Tin.—The tone of the market for standard tin is steadily maintained, notwithstanding the ominous political outlook and a still restricted home demand. The statistical position is, however, regarded as fairly favourable, while an active buying movement on the part of American consumers is also in evidence. Producers in Banca and in China are still holding for higher prices, and practically no business is recorded from these quarters. Shipments from the Straits are not likely to exceed 5,000 tons for September, so that the end of the month returns should be satisfactory from a market point of view. Current quotations :—*Cash* : Wednesday, £160 17s. 6d. ; Thursday, £161 12s. 6d. ; Friday, £163 17s. 6d. ; Monday, £164 7s. 6d. ; Tuesday, £164 15s. *Three Months* : Wednesday, £162 2s. 6d. ; Thursday, £162 15s. ; Friday, £164 10s. ; Monday, £165 7s. 6d. ; Tuesday, £165 12s. 6d.

Spelter.—An active business has developed of late in the market for this metal, due, it may be inferred, to speculative buying on American account, that country reporting a shortage of supplies. The price has accordingly reached the highest record figure in 1920. Current quotations :—*Ordinary* : Wednesday, £32 5s. ; Thursday, £32 5s. ; Friday, £32 7s. 6d. ; Monday, £32 10s. ; Tuesday, £32 15s.

Lead.—Rather freer offerings of nearby delivery have caused a variation in the price of soft foreign pig, which registers a fall of several shillings per ton, whilst forward shipment does not show much change. The American situation continues favourable, with an excellent demand from consuming centres. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 2s. 6d. ; Thursday, £24 12s. 6d. ; Friday, £24 15s. ; Monday, £25 ; Tuesday, £25 5s.

TRADE SIROCCO MARK

CENTRIFUGAL FANS

For Supplying Blast to

Cupolas and Forge Fires.

Made in a large variety of sizes and suitable for pressures up to 30-in. W.G. The Fans have cast iron casings and the belt driven type are fitted with Ball Bearings.

Send for particulars to :—

DAVIDSON & CO., LTD.,

Sirocco Engineering Works, Belfast.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams : "LOWOOD, DEEPCAR."

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	10	0
Three months	64	2	6
Electrolytic	71	10	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	72	5	0
Do. Oct.	72	5	0
Do. Nov.	72	0	0
Ingot bars	72	0	0
H.C. wire rods	77	0	0
Off. aver. cash, Sept.	63	3	4 5/7
Do. 3 mths., Sept.	63	12	5 3/7
Do. Settlement Sept.	63	2	11 5/7
Do. Electro, Sept.	71	3	2 4/7
Do. B.S., Sept.	67	0	0
Aver. spot price, copper, Sept.	63	2	7½
Do. Electro, Sept.	71	8	1

Solid drawn tubes .. 13⅜d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10⅜d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8¼d.
Do. 4x3 Sheets .. 9¼d

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes 13½d
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

Standard cash	164	15	0
Three Months	165	12	6
English	164	0	0
Bars	166	0	0
Chinese	163	5	0
Straits	165	0	0
Australian	165	0	0
Eastern	167	0	0
Banca	165	0	0
Off. aver., cash, Sept.	160	2	8 1/7
Do. 3 mths., Sept.	160	0	7 6/7
Do. Sttlment. Sept.	160	2	3 1/7
Aver. spot, Sept.	160	1	3¾

SPELTER.

Ordinary	32	15	0
Remelted	30	15	0
Hard	24	10	0
Electro 99.9	35	10	0
English	32	12	6
India	25	5	0
Prime Western	32	12	6
Zinc dust	48	0	0
Zinc ashes	10	10	0
Off. aver., Sept.	31	8	8 2/14
Aver., spot, Sept.	31	14	10½

LEAD.

Soft foreign ppt	25	5	0
English	26	5	0
Off. average, Sept.	23	16	3 5/14
Average spot, Sept.	24	2	9

ZINC SHEETS.

Zinc sheets, English	38	0	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	5	0
Boiler plates	36	0	0
Battery plates	36	10	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	15	10	0

QUICKSILVER.

Quicksilver 13 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 0 0
75% 20 10 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% 8/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1 lb.

Ferro-phosphorus, 20/23%, £27

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/11 lb.

Ferro-chrome—
4/6% car. £23 0
6/8% car. .. £22 12 6
8/10% car. .. £22 5

Ferro-chrome—
Max. 2% car. .. £55
Max. 1% car. .. £68
Max. 0.70% car. .. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £145

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 4/9 lb.

Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. 2 d. 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.
Heavy Steel	3	7	6
Bundled steel & shearings	2	17	6
Mixed iron & steel	2	17	6
Heavy cast iron	3	5	0
Good machinery for foundries	3	12	6

	£	s.	d.
Heavy Steel	3	12	6
Bundled steel & shearings	3	5	0
Mixed iron & steel	3	2	6
Heavy cast iron	3	15	0
Good machinery for foundries	4	0	0

Cleveland—			
Heavy steel	3	5	0
Steel turnings	2	10	0
Cast-iron borings	2	10	0
Heavy forge	3	12	6
Bushelled scrap	2	15	0
Cast-iron scrap	3	10	0

Lancashire—			
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	20	0	0
Tea lead	17	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	95/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	105/-
,, No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	101/-
W.C. hematite	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, fonndry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ⅜in.	9	5	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1¼in.	8	5	0

	£	s.
Rails, heavy	8	15
Fishplates	14	10
Hoops	11	10
Black sheets, 24 g.	12	0
Galv. cor. sheets, 24 g.	16	5
Galv. fencing wire, 8 g. plain	16	0
Rivets, ¾ in. dia	12	15
Billets, soft	7 0 0 to 7	2
Billets, hard	8	0
Sheet bars	6 17 6 to 7	7

PHOSPHOR BRONZE.

	Per ba
Strip	1
Sheet	1
Wire	1
Rods	1
Tubes	1
Castings	1

Delivery 3 cwt. free to a town.
10% phosphor copper, £ above price of B.S.
15% phosphor copper, £ above price of B.S.
Phosphor tin (5%), £30 abo price of English ingots.
Charles Clifford & So Limited, Birmingham.

NICKEL SILVER, SHEE METAL, WIRE AND TUBE

	Per lb.
Ingots for raising	11d. to 1/
Rolled—	
To 9 in. wide	1/5 to 1/
To 12 in. wide	1/5½ to 1/1
To 15 in. wide	1/6 to 2/
To 18 in. wide	1/6¾ to 2/
To 21 in. wide	1/7½ to 2/
To 25 in. wide	1/8¼ to 2/
Ingots for spoons and forks	11d. to 1/
Ingots rolled to spoon size	1/2 to 1/
Wire round—	
3/0 to 10. G.	1/8½ to 2/

with extras according to gaug

AMERICAN IRON & STEE

At Pittsburgh unless otherwi stated. Dol

No. 2X foundry, Phila.	34.
No. 2 foundry Valley	36.
No. 2 foundry, Birm.	25.
Basic	35.
Bessemer	35.
Malleable	35.
Grey forge	37.
Ferro-manganese 80 % delivered	75.
Bess. rails, h'y, at mill	40.
O.-h. rails, h'y, at mill	40.
Bess. billets	40.
O.-h. billets	40.
O.-h. sheet bars	40.
Wire rods	47.

	Cent
Iron bars, Phila.	2.
Steel bars	2.
Tank plates	2.
Beams, etc.	2.
Skelp, grooved steel	2.
Skelp, sheared steel	2.
Steel hoops	2.
Sheets, black, No. 28	3.
Sheets, galv., No. 28	4.
Sheets, blue an'l'd, 9&10	2.
Wire nails	2.
Plain wire	2.
Barbed wire, galv.	3.
Tinplate, 100-lb. box	$4.

COKE (at ovens).

Welsh foundry ..35/- to 40/
,, furnace ..30/- to 32/
Durham & North. foundry 28/
,, furnace .. 23/
Other Districts, foundry 27/
,, furnace 23/

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Contents.

	PAGE
Working Hours and the Foundry	289
Notes from Canada	290
Testing Malleable Iron	290
An Apprenticeship Course in Foundry Practice.—XIII.	291
German Company News	293
The Ceramic Society	293
Institution of British Foundrymen	294 & 307
Contracts Open	295
Large Vertically-Poured Castings	296
Remaking a Cyder-Press Nut	297
Casting Rail-Races	298
Community of Interests in the German Metal Industry	298
Threatened Stoppage on North-West Coast	298
Cupola Melting Tests with Mixtures Changing During Run	299
Old Methods and their Present-Day Application	300
World's Output of Electric Steel	301
The Trend of American Specifications for Steel Castings	302
Alpax—A New Aluminium Alloy	304
Making Electric Steel Castings	305
Behaviour of Refractories on Heating	306
Malleabilisation of White Iron	306
Teeming Drums	306
Trade Talk	307
Company News	308
Deaths	308
Book Review	308
Iron and Steel Markets	310

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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"Working Hours" and the Foundry.

In August, 1919, a joint committee of the Engineering and National Employers' Federation, the Shipbuilding Employers' Federation and Unions' Negotiating Committee was formed to investigate the economic relation of production to hours of work. It consisted of equal representation of both employer and employé. The report has just been published, and contains much of interest for foundrymen apart from any political issues with which we do not deal in these columns, confining ourselves to drawing the attention of our readers to matters concerning production. This, we take it, is within our province. Before dealing with this aspect, however, it is worth while noting that no foundryman could read this report without realising the immense importance of his work. To give some random quotations: "The restriction of output in the foundry prevented the employment of more people in the machine shops." "The shortage of castings was preventing the employment of more workpeople in other departments." "It was stated that the moulders' strike had caused greater injury to the industry than any other strike which had ever occurred, and as a result of the refusal to work overtime after the strike was over, they had lost a great number of orders which otherwise would have come into the works, and the present (August, 1921) unemployment in the engineering industry would have been largely avoided or in any event postponed for several months." Now all this points out in the clearest possible manner that foundry work is a key industry, and all connected with it have the undoubted right of assuming that their social and industrial status is in every way equal to that of allied trades. It is certainly worthy of something better than the conditions existing in Firm No. 2 reported on by Committee, about which they say, "The foundry is a converted dwelling house. The character of the work is against moulding machines." It is existence of this type of foundry that lowers the status of the industry.

The Report includes a section devoted to visits to works in Belgium, Germany and Holland in April and May of last year, and in it are some interesting references to foundry work. For instance, at the Ateliers de Constructions Electriques de Charleroi concern, the Committee report that, "In the foundry 95 men and boys are employed in moulding, piece work being the rule both for hand moulding and machine moulding. Their present output is 210 tons per ton as compared with 165 tons per month with 75 employés before the war. Pneumatic hammers are used for fettling, and it was stated the men preferred them." Leaving the Continental report for a moment, it is interesting to compare the above with the written reply received from Firm No. 14 in answer to a questionaire: "The foundry is old and the ventilation not very good, but the crane equipment is efficient and pneumatic and hydraulic machines had been installed but abandoned in favour of hand-operated machines as being more satisfactory. Pneumatic appliances had been abandoned in the fettling shop on account of the very high cost of maintenance." We refrain from the obvious comment!

To return to the Continental section of the Report. Dealing with the De Fries concern of Düsseldorf, Germany, the Committee, reporting on the efficiency of production, state: "For the foundry the average figures for the years 1910-14 were 35 tons per man per year. Output in 1919 had fallen to 22 tons per year, and in 1920 to 21 tons per year per man. The low output of 1920, however, was apparently attributed to the fact that trade was slack with them at the time. It was noticed that men were using pneumatic rammers in the foundry, and that satisfactory results were being obtained from them."

The only mention of the foundry during the Dutch visit was at the works of the Werf Conrad firm at Haarlem, near Amsterdam, where the Committee, reporting on efficiency, state: "They (the Dutch) have no difficulty whatever with regard to demarcation, *e.g.*, the floating dock being urgently required for a ship that was coming in, the whole of the foundrymen turned out to paint the bottom of the ship in dock, in order to get her out in time." This should enhance the reputation of foundrymen as handy men!

No attempt has been made by the Committee to arrive at any general conclusions, but some are so obvious that it may be worth while if we draw attention to them in a non-committal way. As

already set out, a perusal of the Report cannot help but impress one of the importance of foundry work to shipbuilding and engineering. The second feature is the necessity for the closest co-operation of all concerned. Another deduction is that industry, in the largest sense of the word, is more prosperous where individual piece work can be arranged, and after that some of the many schemes of bonus on output. Payment on a time basis does not appear to pay the individual or the master. Another factor which impresses the reader is the prevalence of slackness at the beginning and end of shifts. To give two quotations from the Report on this subject: "The Committee when going through the yard noticed from 11.35 a.m. till noon, when the works stopped for the dinner hour, considerable numbers of men had ceased work and were proceeding to the main exits, large numbers being gathered at the time office when the buzzer blew." "There were many complaints as to the slackness of the men in both starting and stopping work, and the Committee saw for themselves plentiful evidence of this disgraceful state of affairs in the portion of the works they happened to be in, just before 12 noon."

A pleasing feature is the progress which had been made in recent years in welfare work.

The influence of trade union restrictions on overtime, and its bearing on the loss of orders and consequent unemployment, also forms an important section. Apart from its political aspect, the Report is well worth the closest study by all foundrymen genuinely interested in the general welfare of the industry at large. If it is to withstand the ravages of foreign competition the employers on the one side must provide the very best equipment and the employés on the other side must learn to use them intelligently. In other words, the converted-house type of foundry must disappear, together with any antipathy to labour-aiding devices.

Notes from Canada.

Messrs. J. D. Shipton and A. W. Noble, of Vancouver, are reported to be negotiating with the municipality of Chilliwack for a free site on which to establish an iron and steel plant. Mr. Noble states that control has been obtained of ten iron-ore claims, and that there is plenty of high-grade coal in the district.

The British Empire Steel Corporation's mines on Belle Isle, Newfoundland, are working night and day on the shipping of Wabana iron ore direct to German ports. The steamers, "Henrick Ibsen," 7,100 tons; "Greldon," 7,500 tons; and "Cymric," 6,200 tons, all sailed recently for Bremerhaven, and several other ships were scheduled to clear at a later date.

The large plant of the International Nickel Company, Limited, at Copper Cliff, Ontario, recommenced operations on September 1 last, after having been closed down for 18 months. The Company is operating at one-third of its capacity, and it is proposed to work with 650 hands. Regular consignments of matte will be made to the refinery at Port Colborne, Ontario, where all of the refining is to be done hereafter, the plant at Bayonne, N.J., having been scrapped. The refined nickel will be despatched to the new rolling mills at Huntingdon, Virginia, where it will be rolled into malleable metal and marketed mostly in the United States.

The local press at Sault Ste. Marie, Ontario, in commenting upon the large loss sustained by the Algoma Steel Corporation on last year's operations, hints at some important changes in connection with that Company. Rail-making has not proved to be a profitable business in the past, and it seems likely that, by reason of reduced demand and more competition, it may be even less so in the future. There are now three trans-continental railway lines across the Dominion, two more lines are well under way to Hudson's Bay, and there is the prospect of constructing a deeper waterway from the Atlantic through the St. Lawrence and Great Lakes to the middle of the continent. These systems of transport will be more than ample to handle the heavy freight likely to be available in Canada for many years to come. The demand for rails in future will therefore be limited to repairs and to short feeding branch lines, calling for a steady output, though one not reaching to the huge demand occasioned in the past by the construction of long trunk roads. The Corporation's structural steel plant, manufacturing a material for which there is an ever-growing demand, with little competition from other Canadian concerns, will therefore in all probability be the main standby, and other lines of manufacture will be added.

Testing Malleable Iron.*

Section by M. L. Piedbœuf.

At the Liège Congress in 1921, M. Remy suggested that research should be conducted on the subject of testing malleable iron. The author has established the following system at the Fonderies et Ateliers Simonon, at Herstal, which has been found to be successful for the daily control of manufacture.

Chemical Analysis.

The pigs used possess fairly regular composition, so much so that it is now possible to control satisfactorily the contents which are subject to variation. Grey pigs contain about 3.5 per cent. carbon and 1 per cent. silicon. Phosphorus does not exceed 0.15, and sulphur 0.05. It has been found, however, that the silicon content is very variable, so much so, that this element must be analysed from samples taken from each wagon received. It is necessary that the silicon content in the charge must always be maintained within certain limits if trouble is to be avoided.

White iron contains up to 0.15 per cent. sulphur, and it is obviously necessary to institute a control. The charge is so arranged that the quantity of white iron used is reduced to a minimum. It is equally useful to control periodically the silicon and sulphur content in the hard castings. This is particularly necessary in foundries which are engaged principally upon the manufacture of light castings.

Because of the considerable proportion of runner scrap used there is introduced a progressive increase in the sulphur content. When this has a tendency to become high, the runners and risers are subjected to a special desulphurising treatment in order to reduce them to a normal proportion.

Mechanical Testing.

After having tried various types of tensile and bending test-pieces, the American bending type having a thickness of from 12.7 to 1.5 mm. has been finally adopted. These bending tests have given good results from the point of view of daily control, two being taken from each cast. The first one is useful for checking the condition of the hard iron, and the second for determining the strength as shown by bending after decarbonisation. After bending the tests undergo a microscopic control so as to determine the constitution of the iron from this aspect.

The work of the annealing furnaces is controlled by registering pyrometers.

The difficulties associated with moulding test-pieces and the carrying out of the tests, also the very irregular results obtained, do not appeal to foundrymen. The system adopted in the author's foundry appears to be one which could be adopted by the majority of foundries manufacturing malleable iron.

It is interesting to note that the Germans have sent round the following questionnaire dealing with the conditions for testing and buying for the malleable trade:—

(1) What chemical composition do you consider best? (2) What types of physical test, particularly tensile tests, do you favour? (3) What type of test-piece should be adopted for tensile testing? (4) What do you consider to be the minimum values for the tensile strength and elongation? (5) Should malleable iron be divided into different quality categories, their being based upon the tensile strength and the elongation? (6) Are tensile tests necessary for ordinary malleable or is it necessary to take test-pieces from a definite number of castings? (7) Is it necessary to try to establish certain typical test-pieces, in order to facilitate the obtaining of comparative tests of the density of the metal? (8) What specific gravity do you consider normal? (9) What do you consider the normal contraction to be? (10) What special conditions ought to be laid down for malleables to be utilised for magneto and dynamo work?

The author proposes that the following should be added:—(*a*) How can good test-pieces be cast under foundry conditions? (*b*) What allowances can be normally tolerated between the dimensions of the castings and those given on the blue prints? (*c*) Should scrap due to badly-designed patterns be charged to the foundry or the customer?

* Abstract of a paper read before the A.T.F.

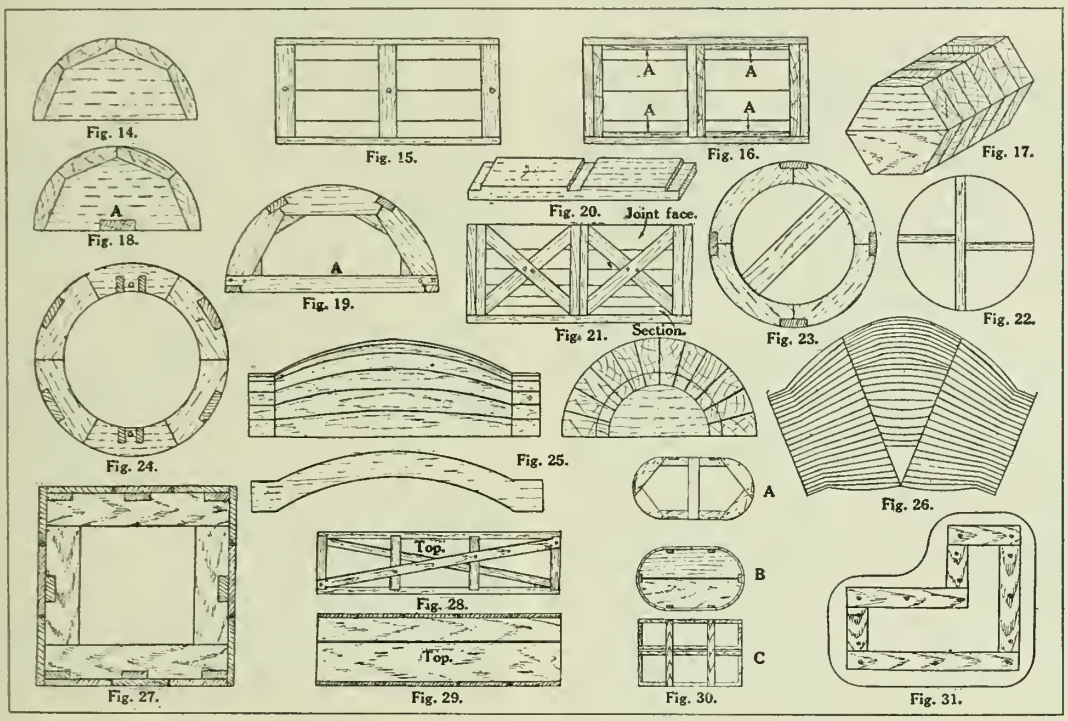
An Apprenticeship Course in Foundry Practice.—XIII.

By Ben Shaw and James Edgar.

METHODS USED IN PATTERN CONSTRUCTION.

PART 2.

Barrel Construction.—Boxed-up construction, in many cases, consists of lagging fastened to grounds, and patternmakers usually identify lagged work as barrel making. When a comparatively long cylindrical for of over 6 in. dia. has to be made it ought to bo built with lagging on the grounds. Built thus, it will be much more durable than if made from solid timber, and incidentally it would be much lighter. There are many barrel constructions, and much depends not only on the size of the pattern but on whether it will bo moulded on end or not. Barrels for end moulding are always made in one piece unless when of very large diameter, then it may bo convenient to box up a square centre and complete the diameter with segments, but, if for horizontal moulding, they should be in two halves dowelled together.



Small Barrels.

Figs. 14 and 15 illustrate a method of construction which is very suitable for sizes up to 10 or 12 in. dia. which will not be required for many castings. Fig. 14 is an end view and Fig. 16 a join view. The grounds should be 1¾ or 2 in. thick, and not more than 18 in. apart. There cannot be too many grounds, and if the number is limited so that they are placed too far apart in a long barrel the pattern will not long withstand the rather rough usage of the foundry. The shape of the grounds is determined by the size of the barrel, as the staves should not be wider than 4½ in., thus they may be hexagonal, octagonal, etc. Some patternmakers nail barrels, but it is much better to screw them, especially if for a standard pattern. For a standard pattern, however, a better-quality barrel would be made. If the timber used for a half-barrel similar to Fig. 15 is wet, or if the pattern is carelessly left in the damp sand, it will become either less or more than a half-circle. This danger can be obviated by crossing the grounds as shown in Fig. 16, and it is good practice to nail strips A between the grounds, thus preventing any possibility of them being knocked in and also providing rapping surfaces for the moulder. With regard to stave thickness, this should not be less than 1 in. on small barrels; it is customary to use 1¼-in. timber. In some shops staves are planed concave and convex on the thickness-planing machine, and it is not customary to turn barrels. A turned barrel, however, is in all cases much superior to a planed barrel.

In commencing to make a barrel, the constructional view of the end should be set down in the first place. Very little should be left for turning at the middle of the staves. The grounds should not be drawn and sawn separately, but those for each half screwed together (see Fig. 17), both faces of each ground and one edge have been planed. The two sets should then be dowelled together, centre lines drawn on the faces and squared on the ends. The shape can then be drawn on each end, whether they are for canted or circular grounds, and, after being bandsawn, they may be either planed or sand-papered on a disc machine. With regard to the staves, very little hand-planing should be necessary if care is taken in setting the planing machine fence at the correct angle. The staves should not be left more than 1/16 in. larger than the finished size. To build the barrel, a thick building-board slightly narrower than the width of the grounds should be used and a centre line gauged on it. The position of the grounds may then be marked after which they can be screwed to the board. In building any size of staved barrel it is always advisable to start with the centre stave. When the joint is reached a 1/16 in. may be left over for final flushing. Either one or two screws should be used in the width of each stave into each ground. In boring the screw holes, centre bit holes, large enough to receive the heads of the screws to be used, should first be bored, and their depth should be sufficient to enable the screws being countersunk at least ¼ in. below the finished diameter of the barrels. When the staves have been screwed on the grounds these holes are plugged, and for this purpose short lengths of wood having the grain running with the staves may be planed up. These plugs should be tight-fitting and driven in after being dipped in hot glue. A practice to be recommended when building barrels with grounds about 12 in. wide is to set in a checked stay as shown at A, Fig. 18, before fitting on the staves. This serves the same purpose as strips nailed between the grounds in that it prevents them from being accidentally knocked in.

Large Barrels.

While the construction described above is satisfactory for small barrels, it is really suitable for large barrels that have to be made in halves, although in some patternshops the grounds for the largest size of barrels are made of two thicknesses of timber crossed and without any additional staying. A better form of construction is that shown at Fig. 19. This consists of two thicknesses of 1- or 1¼-in. timber crossed, although the rail, A, need only be half the thickness of the grounds. After these grounds have been built they should all be screwed together and the slots sawn out at the band-saw. Very little finishing with plane and chisel should be necessary. In building a barrel of this description the stays should first be screwed into position. The stays, similar to Fig. 20, it may be mentioned, should be about 4 in. wide and 2 in. thick, with a check or shoulder at least ½ in. deep. As an alternative to checked stays, some patternmakers adopt the method of using diagonal stays (Fig. 21), but it does not result in as strong a construction and it is not a much quicker method. The number of stays used, of course, depends upon the size of the barrel. While four stays as shown at Fig. 19 are satisfactory for barrels up to about 2 ft. 6 in., more are necessary for larger barrels.

End-Moulded Barrels.

Barrels for end moulding must be tapered, the amount of taper depending to some extent on the requirements of the foundry, but we shall not concern ourselves here with taper, but confine our attention to actual constructional details. For small sizes—up to 12 in. in diameter—the grounds should be of crossed timber as for half-barrels, but instead of stays, frames or simple boards about 1¾ in. or 2 in. thick are used to support the grounds (Fig. 22). An important feature of this construction is that, if a plate is set into the bottom ground and a rod lowered through the pattern, the frames which clear the centre serve as a guide for the rod. Building such a barrel does not cause much difficulty, if care is taken, before the lagging is screwed on, to ensure that the framework is not twisted. This can most easily be done by placing the construction with a ground resting on a level board and testing with a set square.

With complete barrels—barrels that are not in halves—that are of larger size than the foregoing, rings must be built segmentally either 4 or 6 segments to the diameter, and stays and cross rails screwed on the under side of the frames or built into the rings for the lifting rod, as shown at Fig. 23. For the very largest type of barrels two lifting rods may be necessary, and the frames must be strengthened on either side of the rods. This is clearly shown at Fig. 24. This construction is only adopted for very long barrels of large diameter such as are used for propeller brackets. For these large barrels the lagging should be proportionately heavy, in some cases being 2 in. thick to withstand the pressure of sand during the time of ramming.

So far we have only dealt with parallel barrels, but barrels have frequently to be made for large valves. A very common design of valve is that known as the through valve. For small and medium sizes these may be made solid, but when large it is necessary to build them. The grounds are crossed in the usual way, but the lagging must be sawn to allow at least 3/16 in. for turning and, in order to economise timber as well as to reduce weight, they should not be more than 2 in. wide. The whole construction is made clear in Fig. 25. The lagging may be sawn or machine-planed to the correct taper. When building such a pattern only every third or fourth stave should be screwed into the grounds, but the staves should be screwed to each other. This is a very strong constructional method, and is suitable for many designs of valves. It may appear costly, but if the proper use is made of the various machines it need not be so. Fig. 26 shows a valve that has been lagged up in this way; of course in this case a joint frame would have to be made and on this the pattern built. The middle portion would be the most difficult, as all the staves are of different lengths.

The methods just described do not cover the subject, but we believe, from an extended experience, that they are the best methods. In some shops, even when building large barrels for cylinders and condensers, it is the practice to substitute the shouldered stay by distance frames. The mode of procedure when this is done is to make the grounds first and carefully draw centre lines on them, after which one ground is temporarily screwed to a level floor or to "skids"—these being two or three runners about 2 in. thick which are fastened to the floor and levelled. The set of frames are now placed on the bottom ground and the second ground placed on top of them. Either a set square can now be used to test the work, or a straight-edge may be placed to the centre lines of the ground and a plumb dropped to the line on the floor. The operation is repeated as each ground is placed on the distance frames and secured after the correct position is located. A very sound job is obtained in this way, but it is not recommended for other than large cylinder or condenser barrels, when the whole pattern work may be built on the barrel from lines drawn on the level floor, and thus a slight twist of the barrel would cause trouble when assembling the various parts.

With large barrels the principle of having open joints to localise any change of form due to the timber either absorbing or giving off moisture is frequently resorted to, particularly if it is to be used for many castings over a long period. Even though the barrels may be painted, the moisture has access to the inside, and open joints are an advantage for work of a standardised character. An open joint may be left between each stave, but it is better to make alternative joints or every third joint open about ⅛ in. when it is desirable to maintain as true a shape as possible over a long period.

Boxing Up.

Many patterns are spoilt because of the faulty construction of the main body. Some patternmakers think that if thick timber is used strength is assured, whereas some of the lightest patterns are the strongest. We have seen cylinder patterns made of teak and almost solid, but such work does not reflect great credit on the shop which turns it out. In the South of England the tendency generally is for too-thick timber to be used for many purposes, while on the Clyde they go to the opposite extreme and build too flimsy work. Correct jointing and construction are exceptionally important, and a heavy pattern that is badly constructed is weak in proportion to its weight.

We may, for the purpose of this article, define boxing up as the construction of square, rectangular, and irregular-shaped bodies which cannot very well be made in any other way or because they lend themselves to the method more than to the staving or segmental methods. The young patternmaker is often in a dilemma, when making a shallow pattern, as to whether it ought to be made from the solid or boxed up. There can be no hard-and-fast rule. A boxed-up pattern is always the stronger, although it is unnecessary to box up a small square pattern 3 in. thick.

In a previous article concerning the jointing of timber, we described the best method of making small boxes, but it was only suitable for work up to 12 or 14 in. square. Above this size it is necessary to make frames. The method of making a framed square construction does not differ very materially from the method of building a barrel. Fig. 27 shows such a box. The frames should be made of rails about 4½ in. wide and 1¾ or 2 in. thick, but the lagging need not be more than ⅞ or 1 in. The stays are shouldered on to the frames. If accuracy is observed when planing the frames it should only be necessary to clean the outside afterwards. There ought, however, to be taper in the depth, and it is much easier to plane this, if it is not over ⅛ in., than make the frames of different sizes. If it is intended to use a centre rod for lifting it out of the mould special battens must be screwed on the underside of the frames. If the frames are much over 18 in. square, of course centre rails are necessary. Lifting straps are frequently used instead of rods for square and rectangular patterns, and these should be fitted where the lagging is strengthened by

stays. The lagging or covering boards should, for all boxed-up patterns, be screwed on so that the grain will be vertical in the mould. If this is not done the side of the mould may be badly damaged when drawing out the pattern. For building very long rectangular box-shapes, various methods are adopted, but whichever method is adopted, parallel straight-edges should be in almost continuous use to prevent the possibility of a twisted construction. Frames are necessary for every 18 in. of length, and in some pattern-shops longitudinal stays are thought sufficient. It is better, however, in addition to side stays for supporting the covering boards, to fit diagonal pieces as shown at Fig. 28. It is nearly impossible for work to get out of square when this is done. It will be noticed (Fig. 29) that both top and bottom boards run lengthwise of the pattern.

The forms we have described are regular, but when the general principles governing good boxing up are grasped, there is no difficulty in applying them to any shape.

When it is necessary or advisable to fill in the frames this is easily done by sawing checks from the rails before they are screwed together in order that a panel may rest on them.

Before leaving the subject of boxing up, it may be well to consider one or two other fairly common shapes, as, for instance, that shown at Fig. 30 B. The method of construction does not, as will be evident from the sketches, differ much from an ordinary rectangular block. When it is not a very large pattern solid plates are made. In really high-class work these plates should be crossed as described in making the grounds for barrels and, if large, frames should be made (A Fig. 30). It may be necessary, when making such a pattern, to joint it in the centre because of branches or to facilitate coring, and it is much more satisfactory to build the pattern in one length and saw it in two afterwards. All that is necessary is to keep the centre plates, as shown at C Fig. 30, about ½ in. apart with distance pieces to allow for a saw cut. It increases the effectiveness of the method if the centre plates are dowelled together before the stays are screwed on.

Many large branches have to be boxed up, and sometimes these tax the ingenuity of the pattern-maker, and he may have to adopt a partly-solid and partly-boxed construction. It is the practice in some shops to make plates to the finished size of the work and then build between check pieces, which are frames keeping the plates the correct distance apart and are screwed to the plates, as shown at Fig. 31, but it is not as good a construction as making grounds and covering them.

German Company News.

The financial results of various companies for 1921-22 are given below in marks, and the corresponding figures for the preceding year are shown in parentheses :—

Van der Zypen & Wissen United Steel Works Company, Cologne-Deutz. Gross profits, 40,102,000 (19,948,000); written off for depreciation, 3,065,000 (3,758,000); net profits, 37,036,000 (16,190,000); dividend at rate of 100 per cent. (30).

Annen Cast Steel Works Company, Annen. Depreciation, 1,140,000 (710,000); net profits, 1,240,000 (3,130,000); dividend, 15 per cent. (15).

Rombach Ironworks Company, Coblence.—Dividend at the rate of 25 per cent. (16).

Gaggenau Ironworks Company. — Depreciation, 3,349,000 (784,000); net profits, 7,874,000 (2,152,000); dividend, 25 per cent. (12).

Geisweid Ironworks Company.—Dividend at the rate of 50 per cent. (32).

Allgemeine Elektrizitäts Gesellschaft proposes to pay a dividend of 25 per cent. and to increase its capital by 300,000,000 marks.

Harkortsche Bergwerke und Chemische Fabriken, of Gotha, proposes to pay a dividend of 50 per cent. and a bonus of 100 per cent.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to F. Griffin, trading as F. Griffin & Company, 34, Great St. Helens, London, E.C.3, and T. S. Sutton, trading as Thomas S. Sutton & Sons, Gas Works Road, Neath.

The Ceramic Society.

Autumn Meeting at Birmingham.

The Autumn Meeting of the Refractory Materials Section of the Ceramic Society was held at the Birmingham Chamber of Commerce on October 3 and 4, Lt.-Col. C. W. Thomas presiding. Abstracts from two of the Papers are given below.

Some New Forms of Kilns.

In his Paper on this subject, which was illustrated by lantern slides, Sir Arthur Duckham described, in the first place, a continuous kiln of 16 chambers, each 19 ft. 1½ in. wide, 16 ft. 9 in. long, and 6 ft. high to the springing of the arch. They were arranged in two rows, side by side, and each chamber had four fire-holes and bags, the firing being semi-gaseous. The kiln was used for burning Stourbridge firebricks made of local clay, with clay grog and silica. Each chamber contained 60 tons of material, and 14 or 15 chambers were burned per month, the fuel consumption amounting to 20 to 25 tons of coal per 100 tons of material. During the burning, two chambers ahead of the firing chamber and two behind were worked at the same time. It was found necessary to substitute artificial draft for natural draft to ensure satisfactory results under all conditions, and this also increased the output.

A kiln known as the W.D. Central Bag Kiln has the important advantages that uniform heating is obtained; the centrally-situated bag can be made of different material from that of the kiln itself; proper combustion of the heating gases is assured, and the brickwork of the kiln proper is never subject to the direct action of the heating gases during combustion. Satisfactory results have been obtained from a single chamber of this type, with an outside gas producer burning coal.

In order to overcome the disadvantages of tunnel kilns, two modified kilns of that type were designed. An open-tunnel kiln had cross walls on each truck carrying the material, the cross walls registering with offsets on the kiln walls, so that the gases were forced to take a zig-zag path. In this way the length of the kiln can be reduced from 300 ft. to 130 ft. Other special arrangements help in securing uniform heating and proper cooling. An annular tunnel kiln was designed for the slow and uniform firing of large glazed goods at about 1,100 deg. C., the heating gases being muffled. At the unloading and loading point the continuity of the tunnel is interrupted, but the annular firebrick tray carrying the material is continuous and unbroken. Producer gas is used for heating the kiln, combustion taking place in six separate horizontal flues situated one above another in the side walls of the tunnel. Mechanical draft is supplied by means of a fan and motor. The chief advantages of this kiln are convenience of working, elimination of trucks, uniform heating, and economy of fuel.

The Grading of Silica Bricks.

In this Paper Messrs. P. B. Robinson and W. J. Rees gave grade analyses of green bricks, and correlated them with the properties of the corresponding burned bricks. In general about 40 per cent. of the material was found to remain on a 30-mesh sieve, and about 40 per cent. passed through a sieve with 100 meshes to the inch. Grading curves indicated that it was impossible, with ordinary pan mill crushing, to get sufficient fine material to give a brick of appreciably less porosity than those at present made, as increased time of grinding only led to the production (in the various ganisters examined) of material of about 100 mesh size (0.2-0.3 mm.), and it was shown that for the production of a dense brick fine-ground material from a ball mill must be added.

The conclusions reached by the authors were that (*a*) a hard rock crushing into fragments of high angularity should be used, (*b*) the best sizes for the largest pieces in the brick are 6-7 mm., which impart strength at high and low temperatures alike, (c) at least 40 per cent. of fine-ground material passing 100 mesh must be present, and for a dense brick (*i.e.*, with less than about 27 per cent. porosity) addition of fine-ground material from a ball mill must be made, and (*d*) the bricks must be well burned.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

The annual meeting was held on Saturday, September 30, 1922. The annual report having been adopted, the election of officers was proceeded with, Mr. H. J. Young being elected as President, Mr. S. W. Wise as Senior Vice-President, and Mr. J. W. Frier as Junior Vice-President of the Branch. The following were elected to the Council: Messrs. Frank Adam, Colin Gresty, T. McPherson, and E. Wood, and Messrs. M. B. Herbst, J. N. Simm, J. D. Carmichael, and J. W. Frier were again appointed as delegates to the General Council. The two reception officers chosen were Messrs. Elliott and S. E. Smith. Mr. H. A. J. Rang was unanimously re-elected as honorary secretary.

Mr. H. J. Young said the Newcastle Branch had lost a very valuable president, Mr. R. O. Patterson having retired according to rule. It was a great honour to Newcastle that Mr. Patterson had been elected as Junior Vice-President of the parent body. A hearty vote of thanks was then accorded to Mr. Patterson.

Mr. Patterson, in reply, said that he had enjoyed his year of office very much and had found it most interesting. He had been exceptionally well backed up by his officers.

Mr. Young then delivered the following address.

Presidential Address.

Ladies and Gentlemen,—Being your President fills me with both delight and dismay—delight that my profession should be so honoured, dismay lest I should make a mess of the job at a time when, above all times, science is most wanted, and most wanting, in the foundry practice of this country.

Science has been described as nothing but good sense and reason; on the other hand, you never met a fool but who thought himself well-stocked with these commodities. The privilege of making a fool of oneself is extended to chemists as well as to other men, but the folly of any particular chemist is no argument against science—though I have frequently heard it used as such by foundrymen.

You will remember the old saying that "Silence is golden." It is really a reporter's error, the correct word being "Science." How did Germany get the money to prepare for and to wage the most expensive war in history? Why is she still one of our most dangerous competitors? Her shipyards and dry docks are choked with work; her manufactures are pouring into this and other enemy countries.

Meanwhile our own men are unemployed by the hundreds of thousands. What does it all mean? I suggest that Germany does it by scientific thinking, scientific manufacture, scientific business methods and finance, scientific methods of education, and scientific defeat, if you like to call it so.

However that may be, this is no time for self-congratulation, and I make no apology for the fact that my address will consist of criticisms of our deficiencies rather than expiations of the undoubted progress made by this Institution.

A man's mind can be so unbalanced that he is unable to tell whether the sun is rising or setting, but the nature of the Britisher is often such that, even after having seen several sunsets, he still remains incapable of recognising the signs of one until darkness falls.

In foundry work especially have we to make a clean sweep of our old ways if we desire to make the sun rise and to prevent it setting. It is absolutely essential that every foundry, or every group of foundries, should have its own laboratory, and this must not be a paltry affair either in equipment or staff. It is essential that every foundry in the country belongs to the Cast Iron Research Association, and then those foundries with laboratories will be in a good position to make the best use of the device and research work of that association.

Ignorance in Foundries.

One would hardly expect a foundryman to be an unread and ignorant person, yet to-day there exist many who know less than nothing about the facts, the most elementary facts, concerning their metals, their sands, their furnaces, or about what the rest of the world is doing and thinking.

This state of things *must* cease if British foundrywork is to hold its own. Unfortunately, far from ceasing, it looks, to judge from the type of boy now coming into the foundry, as if it will get far worse.

Certificated Foundrymen.

I suggest that there would be a great and steady improvement if foundry workers had something to work for, some degree or qualification or status similar to that of the sea-going engineer. The apprentice moulder, at the end of his time, should go through a simple examination and obtain a third-class "ticket," and progressively should he be able to get his second- and first-class ones. Super or extra tickets should be available for those who showed a knowledge of practical science.

This Institution could appoint examiners to hold periodical examinations at the various Branch centres. I think it would raise the whole tone of foundrywork and tend towards better wages and more orders.

Proceedings.

The success of this Institution has been brought about by the efforts of a few hard-working foundrymen, and the majority, apart from being members, contribute little towards it. What is the result? The main result is that the Institution has been unable to do many things it should have done and wanted to do. I will detail some of these things.

Your transactions are printed and bound in such manner as to be almost valueless, they are not indexed, and are issued about eighteen months late. What I say to-night and what other speakers say this session will appear in transactions reaching you, at the normal rate of progress, late in the autumn of the year after next year—namely, September or October, 1924.

Test-Bar Research.

The inquiry into the question of cast-iron test-bars is yet another matter. After years of inaction something is started now when it was almost forced down our throats.

Then there is our lack of literature, of abstracts from the foundry work of the world at large, of an information bureau.

Pig-Iron Buying.

Finally, the deplorable position that the foundryman has to purchase such pig-iron as he may be able to afford and to accept it even though it may be far different to its published description; this without any hope of any complaint being of the slightest use. Alternatively, if he wants pig-iron or something approaching a known composition he has to pay an absurd price for it. In one and all these things we have been deplorably apathetic and lax.

Road to Progress.

It may be said that want of money is the cause. I do not believe it. *Want of keenness is the cause; want of money is the effect.* Past history has always proved it to be the case that wealthy men are attracted by the keenness of poorer men and come forward to help their institutions. Demonstrate that you are keen and the rest will follow. We have hardly commenced work yet so how can we expect to be rich. Let us support those who have done so much for this Institution. Let Newcastle Branch set the example. We have about two hundred and fifty members. Why not five hundred? It only means each of us bringing in another one, and some could bring in a dozen if they put a little real enthusiasm into it.

On our books are less than forty boys and ordinary moulders—the very ones we can benefit most we have least of. We should remember that *this is every foundryman's Institution, not particularly our own.* Every employer in this district should become alive to the unique value of

this Institution as an educational school for foundry workers. Managers and foremen should realise that it is their duty to encourage constantly their likely men and boys to join our ranks.

I wish foundrymen would do more reading. The Foundry Trade Journal and books like Moldenke's "Principles of Ironfounding" are far more fascinating than the football news and far cheaper than correspondence school courses. If any man or boy tries diligent reading for one year and then will look at himself I guarantee he will have a shock. Life for him will have become more interesting, more hopeful; he will be serving his country and himself. Shrug our shoulders and we go to the devil and our trade abroad; buck up and the Britisher and his goods are second to none. A member of a society who says nothing and does nothing is like a sovereign at the bottom of the ocean, perhaps a good one, perhaps not, nobody can find out.

I have had many complaints that this Institution and its Branches are "run by" a select few. Then why not start *to discover yourselves* and bring your best men to the front. Night after night in every Branch the same handful of men keep the discussions going, many of you probably know heaps more than these men, but how are we to find it out if you refuse to be discovered.

The last man who criticised us in that way was told by me that he had better start in and do something. Apparently he had not looked upon it in that light before, and the result is that he is giving us a paper this session, and later on he will be helping in our education scheme. Education in our Branch is going ahead this session. It *must* go ahead.

By the interest and kindness of Mr. Summers Hunter you are invited to inspect his works and laboratory. Afterwards, in this hall, I am giving an elementary lecture upon cast iron. A copy of this lecture will be sent to each of you beforehand so that you may read it and keep it. Also we have an educational paper upon dry-sand moulding; another one upon microphotography, telling you how it was done and what the photographs mean. Many lantern slides will be shown at these lectures and they should be very interesting and exceedingly instructive. Also we have the Surtees medals to be won this session.

I appeal to employers and others to give us donations towards the cost of hall, prizes, and so forth, for these educational nights. *It is essential that we have one once every month.* The cost would be trivial, and I feel sure my colleagues on the Council will gladly appoint a committee to deal with this matter. Also I feel sure we can obtain practical men and theoretical men willing to teach us and the lads. Let those interested write to Mr. Rang or myself.

All we need is your enthusiasm and patriotism. We shall get the help we need if we show that we are keen and determined. Foundry work cannot flourish without education, and things are getting worse.

Many of you will wish to attend such evenings, and many of you will be capable of helping in some way or another, by giving lectures, by bringing your lads, and so. If you have any ideas or suggestions please put them forward.

The Work of the Secretary.

This Newcastle Branch depends, and has always depended, upon one man. He has been its one constant source of energy, of unity, and of resource. I often wonder what it must have cost him in time and thought and money. He arranges the whole thing every year, he invites talented men to come and talk to us, he entertains them before and afterwards, he does all the correspondence, the literature, the accounts. The one thing apparently that he does not do is to put himself forward or make a song about it. I ask you to realise what our Secretary has done for us, for our Institution, and for our industry. I want you not to forget it, as I shall refer to it later.

There is no greater contentment than is his who does his level best. It is said that that explains why so many men are discontented nowadays—it may well be true. Get into any lad the doctrine of doing his "level best" and you need worry no further about him. It should be taught and taught again in every church and school in the land. Give your lads a chance *to like work.* To do so is their only hope of happiness and contentment.

I have heard it said at foundrymen's meetings that the boys are ungrateful young devils, and that one gets no thanks or return for what one does. That is utterly and absolutely untrue. Do your bit to the very uttermost, and you will find plenty of thanks within your own heart.

Vote of Thanks.

Mr. Wise, in proposing a vote of thanks to Mr. Young for his excellent address, said that he could not let the occasion pass without deploring the tone of pessimism adopted by Mr. Young. He considered that if the Germans did use science then the British used it even more, and though perhaps the Germans did make progress, nevertheless it must be remembered that they lost the war. He did not think that anyone would say that the German scientist or chemist was any better than the British scientist or chemist. Then with regard to the education of boys, he thought that it was most difficult to get boys in the foundry to take an interest in their work, although great efforts have been made in that direction, but in the future he hoped there would be better results.

Mr. Smith, in seconding the vote of thanks, said that he thought everything Mr. Young had said was possible. He agreed that if a boy made up his mind to do a thing well he could do it. He considered that it was the duty of the older men to help the boys to take more interest in their work.

Mr. Young said he had been told that his address was pessimistic, but no mention was made of the fact that he had said that if the Britisher would buck up he and his goods could beat the world. He considered the Britisher *could* beat the world not by waving the flag and talking about his abilities, but by trying to recognise where he is deficient and working to improve himself. Our boys must be encouraged to work hard, and if the Branch would help by giving educational evenings then, perhaps, at the end of the session he would not be so pessimistic.

Contracts Open.

London, E.C., October 16.—Wheels and axles, for the Bengal-Nagpur Railway Company, Limited. 132, Gresham House, Old Broad Street, London, E.C.2. (Fee, £1 1s., not returnable.)

London, S.W., October 17.—Supply of 1,200 steel tyres for carriage and wagon wheels, for the Madras and Southern Mahratta Railway Company, Limited. 25, Buckingham Palace Road, Westminster, S.W.1. (Fee, £1 1s., not returnable.)

London, W.C., November 15.—Supply of 1,500 galvanised iron or steel tubular poles for telegraph poles, 20 ft. long, schedule 755. Supply Officer, Room 101, Australia House, Strand, London, W.C.2.

Perth, W.A., November 15.—Supply and delivery of 1,490 galvanised tubular poles, for the Postmaster-General's Department, Perth. The Department of Overseas Trade, Room 47, 35, Old Queen Street, London, S.W.1.

Wellington, N.Z., November 28.—Supply of plate girders for the Orepuki-Waiau Railway. The Department of Overseas Trade, Room 50, 35, Old Queen Street, S.W.1.

Wellington, N.Z., October 6-December 12.—Supply of plate girders required for the Lawrence-Roxburgh Railway and the Taneatua Railway. The Department of Overseas Trade, Room 50, 30, Old Queen Street, London, S.W.1.

Mr. David MacLain sails for the States from Liverpool next Saturday. He hopes to pay England another visit next spring, as the tour just ending has been marred by ill-health.

The Royal Metal Trades' Pension Society are holding their annual whist drive in aid of the funds on Saturday, November 4, at the Finsbury Town Hall, Rosebery Avenue, E.C.1. Mr. H. G. Butcher will be in the chair, and will also act as M.C., while the hon. secretaryship is as usual in the capable hands of Mr W. Farmer, 195, Upper Thames Street, E.C.4.

Large Vertically-Poured Castings.

By S. G. Smith.

The castings described in this article are a few examples of important castings which are water-pressure tested, and are required to have clean and sound flange surfaces, except that illustrated in Fig.1. This is an internal flange cylinder, which, whilst not calling for a pressure test, does require the flanges to be quite solid and clean. The dimensions show it to be of medium size. It will be noted that a dross head, not a feeding head, is employed. This is quite necessary to obtain a solid top-flange after machining.

It may be interesting to recall that one firm having obtained a large order for this type of cylinder essayed to make the castings without a dross head, as it entailed additional labour to discard it. In brief, the result was a dirty flange, and the foundry foreman lost his position. This incident is recalled in order to support that a clean top flange, either internal or external, cannot be guaranteed unless a head is applied. Defects in castings of this type that would at one time pass inspection without comment will now often be rejected.

Fig. 1 shows the location of the small flat runner-gates. They are of 1¼ in. by ½ in. section. The number and size of these are usually determined by the temperature of the iron. Owing to their large area, the castings must be poured quickly with a fairly hot and fluid iron.

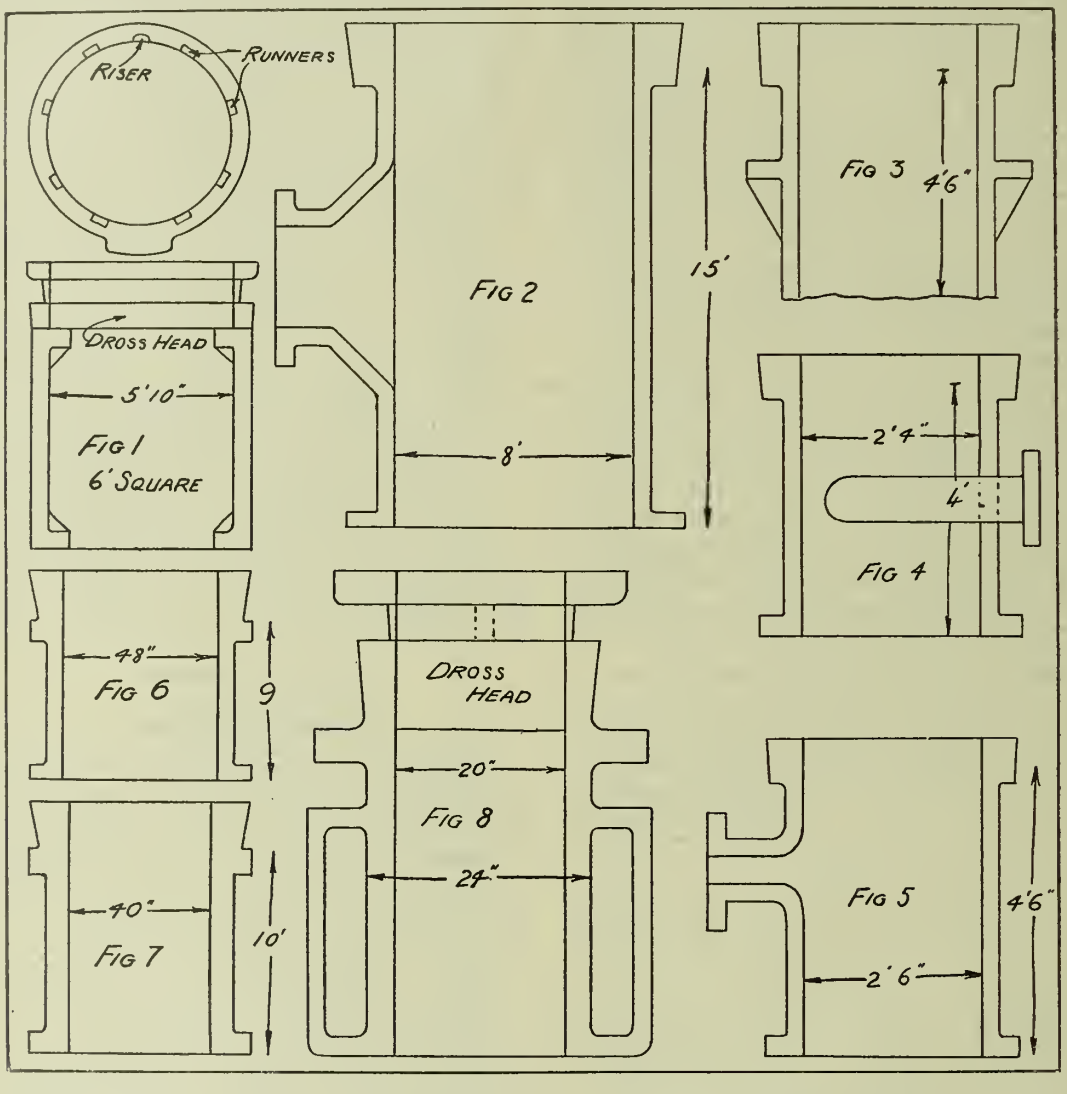
The foregoing remarks are equally applicable to the surface-condenser shell shown in Fig. 2. Such castings can create trouble. For instance, on one occasion, objections had been raised by those in control of the machine shops to a dross head being applied to the top flange of the condenser. The objection was based on the difficulty and time spent in handling such large pieces. This attitude was maintained in spite of the fact that for years much trouble had been experienced on water-pressure testing owing to the difficulty of obtaining a good flange at one end of the casting. This end, without exception, was always the top flange, as poured.

The writer ascertained from the machine shop that it was quite possible to cut off the dross head. All that was involved was a few hours' time and labour.

In possession of this information, the writer pointed out that the sizes, design, etc., of these castings were decided in their own department. They were reminded that the foundry not only handled these castings, but manufactured them from pig-iron, which involved the use of tackle twice the size on the condenser.

As a last resort, the writer insisted that no responsibility would be accepted by the foundry unless the dross head was cast on. This ultimatum was considered by the management, who reluctantly permitted the suggestion by the foundry to be put into effect. Scores of condensers have been made since that time, but not one casting has given trouble under pressure test, or developed defects on the top flange as poured. What has just been stated applies profitably if the casting is machined and not pressure-tested, or, if the casting is not machined and pressure-tested, the precaution (if a little inconvenience and expense is entailed) of putting on a head always favours a good casting.

If it be a flanged casting, such as the above sketches show, the question of section and depth of head is important. Generally speaking, this



may be determined by the thickness, and in some cases the length of casting, but that is not so in the present cases. These castings average 1 in. thick, the flange 1¼ in. thick. The joints are machined and pressure-tested.

It will be noted, with the exception of the 9-ft. flange pipe, that the length of the head, including thickness of flange, is 8 in. To ensure soundness in the flange, this thickness must be taken as a minimum; it will just cover the possibility of porosity due to several causes, also it will be ample to receive the accumulation of dross and dirt. If when the head is cut off the flange is not sound and clean, there is something very unusually wrong.

The chief reason for the head being the width of the flange is simplicity and convenience in moulding for occasional castings, whether in loam or sand. When similar work is required in large numbers, then it would be both advantageous and economical to adopt a design of head such as is shown in Fig. 6, which would necessitate a pattern, if made in sand, but in loam a separate head would need be swept up with a suitable strickle.

From experience with vertical poured castings of almost all descriptions, it can be stated that it is inadvisable to put two or three inches of head on a top flange, it being far better to allow only half an inch. Good fortune in having very favourable conditions may sometimes result in a good clean top flange without a head as suggested, but it will only be occasional.

Referring now to heavy sections of vertically-poured work, such as hydraulic castings, rams, cylinders, etc., any of these may have a mean thickness of from 2 to 4 in., whilst the flanges in some instances exceed 6 in. in thickness. To make such castings water-tight under very high pressure, it is necessary to have much larger dimensions for the feeding heads than those indicated. Also with heavy sections a very much denser iron must be obtained. For castings 1 in. thick a clean ordinary iron, which, in fracture appearance, is between a No. 3 and a No. 4, approximating to the following analysis:—T.C., 3.75; Si., 2.00; P., 1.25; Mn., 0.60; and S., 0.06 per cent. This would meet all requirements, but to make water-tight under pressure, castings from 2 to 5 in. thick would require a very much denser iron. The density should vary directly with the thickness, *id est*, the combined carbon should be increased and the total carbon reduced. A suitable analysis would be:—T.C., 3.00; C.C., 0.70; Si., 1.00; P., 0.75; Mn., 0.75; and S., 0.10 per cent.

The following figures will give some guide regarding the area and depth of head in relation to thickness and section of casting. They are not theoretical, but actual, in practice which have produced satisfactory results.

Fig. 7 is a double-flange casting 10 ft. long, 40 in. dia., 2¾ in. thick, and with flanges 4 in. thick. The flanges were very heavily bracketed, the pitch being 6 in. and the drilled holes centres it. These castings were required to stand an enormous head of water, hence the abnormal thickness. The design of the feeding head, as shown in this figure, is 18 in. long. The moulds were bricked up in loam, and the cores swept up on a barrel. The area and depth of heads for hydraulic pipes would be between those shown in Figs. 6 and 7.

Fig. 8 is a large vertical gas engine cylinder of the jacketed type. The bore being fairly thick and the jacket encircling the greater length, retards the cooling considerably, hence a feeding head of adequate size is needed, and obviously the iron must be dense.

The castings enumerated in this article are chiefly poured with small runners from the top, as shown in Figs. 1 and 8. When convenient, a small runner is carried to the bottom, or part way down, to minimise the splash from the drop. This would apply to Figs. 2 and 8, but not to Figs. 1, 6 and 7.

B.R.C. Fabric, made by the British Reinforced Concrete Engineering Company, Limited, of Manchester, is at present being used for reinforcing the concrete foundations in a portion of Trafalgar Square, London.

Remaking a Cyder-Press Nut.

By S. Cooper.

It has been said, the majority of moulders are imitators. In a great many instances this may be true, but quite often it is found that they have unconsciously been copying a method that was employed many years ago, whilst thinking they were creating an innovation. The following article illustrate this. A and B Fig. 1 represent parts of a cyder press, the latter being a nut, or really the boss of a wheel which is screwed along the steel shaft A. This gives the necessary pressure to reduce the apples to pulp, producing the juices for cyder making. This particular press had been in use a number of years with the result, the threads of the nut were entirely worn away, although the shaft was in very good condition. The job was given to a small country foundry to make the new centre B. It would be a simple job to make a casting and machine-cut the thread, but the foundry, having no machine-shop, could not cut threads, especially of such a size. Additionally it could not afford to have it machined outside, as the nearest works was 12 miles distant.

After considering the matter carefully, the foundry was told to do their best. After burning off the grease from the old casting, it was used as a pattern. A mould was made, jointed along the centre, carefully finished, and for safety, skin dried. Having had some little experience of burning and casting on, it was decided to use the shaft A in place of a core. The shaft was also carefully cleaned, made hot and coated with tar. When the tar had dried hard it was placed in position in the mould and cast. Expecting trouble through the

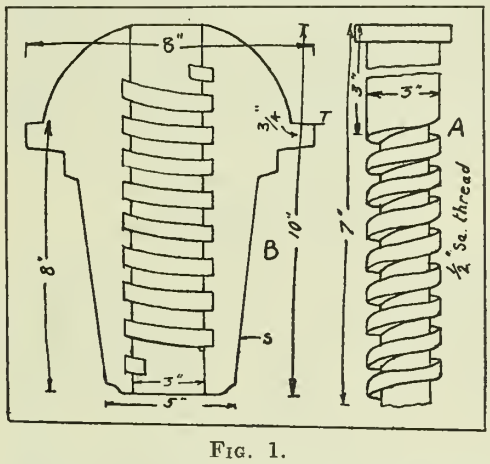


Fig. 1.

metal blowing, a flow-off riser was used, the metal flowing through until everything was quiet. As the shaft became warm the trouble ceased. As soon as the metal became set, it was intended to twist the bolt out of the casting. This could not be done, and the job was left over-night. The following day, when everything was cold, it was possible to move the nut about ½ in. only. From a casting point of view the job was sound and perfect. Therefore, for examination purposes, the casting was broken off the shaft with a sledge and fortunately no damage had been done to the bolt or threads. On re-examining the shaft closely, the cause of the trouble was found to be that although the threads of the shaft appeared to be perfect, there were variations in the size, the maximum being 1/16 in. In addition, there were several small flats in places, which acted similarly to a key on a shaft. This was the cause of the nut refusing to leave the shaft. It was ascertained that this shaft had been in use about 100 years and further, that it had been cut by hand. It was truly a first-class piece of work.

As the foundry wished to produce a piece of work equally as good it was decided to try again. This time the blacksmiths aid was requisitioned. A piece of steel, measuring 1 in. × ½ in., was heated in the forge, and using the bolt as a template, a spiral, was made which could be wound the length of the bolt. A rather slack fit was thus obtained. The coil was made 8 in. long. Taking a core-box 4 in. dia. by 12 in. long, the core was carefully rammed up 2 in. The spiral of steel was

then dropped in the core-box; as the spiral was 4 in. in dia., the core-box kept it perfectly upright and central. The necessary rods for strengthening and venting the core were then placed in position and the remainder of the core rammed to the top of the box. After the core was dried it was carefully rubbed down to 3 in. dia., wet blacked and dried. This gave a core with ½ in. of thread protruding, and the same amount embedded in the core. A further mould was made, but this time on end, and two joints being used for convenience, shown at S and T, Fig. 1. The joint at S being for running purposes. When finished the mould was cored, but prior to this, all blacking was cleaned from the spiral attached to core. As the job was cored several hours before casting the steel work was just touched with oil to prevent dampness. When cast the metal peacefully filled the mould, showing not the least signs of a boil. Next morning a first-class casting was produced, and after being carefully cleaned inside the cored part, a little grease was used to lubricate the threads, and the nut was screwed the full length of the shaft without the least shake or side-play. It will be remembered the spiral was made rather on the slack side, this was to allow the contraction to close it slightly, and just the amount required for the purpose happened to be struck. The contraction of the casting held the spiral safely and firmly in place. No fusion of the two metals, of course, would not take place. The job was an entire success, and after seeing the great pressure and the rough usage to which the screw is subjected, the writer was inclined to be glad the casting in the first instance was a failure. We doubt if it would have held up as the one with the steel threads has done. On tackling this, it was thought that the foundry were using an innovation by using a steel thread. Nothing could be seen of a thread in the old casting, but when it was broken, the old one exhibited the very same method. Thus many years ago, there had been embedded in the cast iron a steel thread ½ in. × ¼ in. After all there may be some truth in the saying moulders are imitators, consciously of unconsciously.

Casting Ball-Races.

Ball-races are usually made from chromium steel. In England, apparently, two specifications are used, the better grade containing 1.25 per cent. carbon and 1.5 per cent. chromium, whilst the cheaper grade has 0.90 to 1.0 per cent. carbon and 1.25 per cent. chromium. In France the writer only found one specification which approximated the mean of the two British ones.

A recent innovation in the manufacture of this steel has recently been brought out by Mr. L. Cammen, who describes his results under the caption of "Chromium Alloy Steel Cast Centrifugally" in a recent issue of the "Iron Age."

He points out that ball-race steel, when cast in an ordinary ingot mould, has a clearly dendritic structure, with large coarse grains, and the carbide is almost entirely in solution.

When centrifugally cast, the alloy is stated to show the same grain on annealing as a forged billet. It opens up important possibilities, and shows that it is possible to cast steel in such a manner as to avoid the dendritic ingot structure.

Mr. Cammen now claims it is now possible, at least for ball-bearing race steel, to produce by simple casting and annealing a material equal in structure to a forging, and thus climinating the forging operation.

The possibilities of centrifugally casting are immense. Readers of this Journal are familiar with the fact that cast iron so treated gives a superior structure associated with better mechanical tests.

The manufacture of railway tyres was dealt with in our last issue.

Threatened Stoppage on North-West Coast.

There is a grave danger of a complete stoppage of all the blast furnaces in Cumberland and North Lancashire owing to the breakdown of negotiations between the West Coast Ironmasters' Association and the Wages Committee of the Cumberland and Lancashire District of the National Union of Blastfurnacemen.

Association Technique de Fonderie.

The Nancy Conference of French foundrymen was opened last Thursday under the chairmanship of Mons. Ramas. The address of welcome was delivered by Mons. Masson, president of the local reception committee The first day was devoted to the reading of four Papers. The first dealt with "Some Factors in Cupola Practice, Influencing the Quality and Strength of Cast Iron," by C. Kluytmans. This was followed by two Papers by Mons. Siegle, the first being "A Thermal Study of the Cupola," and the second, "Inspecting Foundry Raw Material." The last Paper was by Mons. Ronceray, and outlined some work on the malleabilising of white iron by two American investigators, Messrs. White and Gladhill, of the University of Michigan. The afternoon was spent visiting works.

On Friday Mons. Leonard, the President of the Belgian Association, was in the chair. Mons. Ramas then outlined Réaumur's work on malleable cast iron, as this year is the great inventor's centenary. The following Papers were then presented:—(i) "Malleable Foundry Work" (results obtained since the 1921 Liège Congress), by Mons. Marcel Remy. (ii) "A Contribution to the Study of Testing Malleable Iron," by MM. Remy and Piedbœuf. (iii) "Practical Points in the Working of Side-Blown Converters," by Mons. Levoz. (iv) "Malleabilising White Iron," by Professor A. E. White. This Paper was the official American Exchange Paper. (v.) "Ascertaining Foundry Cost Prices," by Mons. Masson, foundry manager, Messrs. A. Ketin, of Sclessin. This was the Belgian official Exchange Paper.

Friday afternoon and Saturday morning were taken up with more visits, the business meeting not starting until 2 o'clock, when Mons. Damour presided. Only three Papers were read at the session, the first being by Mons. Brasseur on "The Electric Furnace and the Brass Foundry." The second deal with "The Influence of Phosphorus on Brass," by Mons. Portevin; and the third related to a new light aluminium alloy called "Alpax," by Mons de Fleury. At 4.30 Mons. Ramas took the chair for the adoption of the balance-sheet and other business. The banquet was held on Sunday evening.

Some abstracts of the Papers are to be found elsewhere in this issue.

Community of Interests in the German Metal Industry.

The Commercial Secretary at Cologne reports that according to the "Kölnische Zeitung" for September 13, it is understood that the negotiations which have been carried on for some time with a view to the formation of a large community of interests between the leading German nickel, aluminium and other metal rolling works have in so far been successful that the supervisory boards are to meet within the next few days to draw up propositions for the consideration of the general meetings to be held in the near future. The community of interests will be formed under the leadership of the Verein deutscher Nickelwerke A.G. at Schwerte-Ruhr. The firms C. Heckmann, Kupfer-und Messingwerke A.G., Duisburg and Berlin, the A.G. Selve, Altona, and several other South German and other firms of the same or similar nature will join the community of interests. The independence of the companies as share companies will remain. The union provides in particular for the joint purchase of raw materials, the joint sale of the products, and other measures which will greatly lessen competition. It is further intended to collect the total profits every year of the works united in the community of interests in the same way as is done in the aniline group, and then to distribute them amongst the various works in a proportion based upon the amount of the share capital.

Considerable damage was done by a fire which broke out recently at the works of the Agra Engineering Company, Old Quay, Teignmouth.

Cupola Melting Tests, with Mixtures Changing During Run.*

By Richard Moldenke, Watching, N.J.

[Slightly abridged.]

As the foundryman oftentimes is confronted with the necessity of running special charges in the first part of his heat to turn out castings of a different character than his regular line of production, he will be interested in knowing what are his chances of keeping the several mixtures separate. The comparatively higher labour costs in America preclude the running of a series of small cupolas, each with its own mixture, as is done in Continental Europe, and hence the single, large cupola must serve with what protection a double-coke charge between the mixtures will give.

It is quite common to find two mixtures run in the day's heat, and occasionally one finds three of them, depending upon the lines of work to be catered for. The smaller tonnage is always put through first, to get it out of the way, and if there are two mixtures for small amounts to be handled, the harder one is charged first. As such extra mixtures usually contain steel scrap—some of them high percentages—it is advisable to make the first charge, one without steel or fine scrap. In the first case the melting steel falling upon the cold bottom will surely stick, and in washing away as the heat progresses affect the succeeding charges unfavourably, apart from giving the first ladle of iron without much benefit from the steel used. In the second case, with fine scrap in the mixture, this will melt quickly and drip down on the bottom before the heavier sectioned iron melts, and thus give an erroneous impression of the height of the bed by yielding a flow of molten iron several minutes too soon.

With the first charge out of the way and the bottom well heated by this iron, and the second charge with its steel first, pig next and lighter scrap on top in uniformly spread layers, an even melting should take place as far as this may be carried out in the cupola process. Placing at least a charge and a half, if not a double charge of coke between mixtures, and pouring the transition metal into work that will be satisfactory with both mixers, a reasonable degree of success can be attained.

Tests with Nickel Chrome.

However, foundrymen will have noticed that the separation of the several mixtures is not nearly as effective as can be wished. For instance, where several charcoal iron charges, having a low phosphorus content, are put into the cupola first, and after putting on a double-coke charge, the subsequent higher phosphorus iron charges go on up to the charging door, it has been noticed that the phosphorus content of almost the first iron is higher than it should have been. This shows that some of the upper charges must have melted along the lining of the cupola, and contaminated the purer iron of the lower charges. Instances of hard iron where soft was expected, and *vice versâ*, are common knowledge in the foundry. The analyses in a series of tests recently made with Mayari pig-iron, which contains nickel-chromium, showed this intermingling of charges so plainly that it was deemed important enough to present to the foundry industry in form of a short report.

An extended research was made for the Bethlehem Steel Company, on the characteristics of their Mayari pig-iron, made from Cuban ores carrying nickel and chromium. The composition of this pig-iron runs about as follows:—

	Per Cent.
Silicon	0.50 up to 3.00
Manganese	0.90
Sulphur	0.03
Phosphorus	0.065
Nickel	1.20
Chromium	2.40
Titanium	0.18
Vanadium	0.05
Total Carbon	4.00

*A Paper presented before the Rochester Meeting of the American Foundrymen's Association.

From this composition it will be seen that the nickel-chromium content is a prominent characteristic, and being so different in this respect from any other pig-iron of the country, it is easily traced in its behaviour in the cupola by the analysis of the metal made. With titanium reduced from the ore, and an almost negligible sulphur and phosphorus content, for cast iron, this pig-iron stands out as rather exceptional. It is gratifying to know that about 500,000,000 tons of this ore is in sight on 25,000 acres in Cuba.

Cupola Tests.

In making up the charges for the cupola, the first one was arranged to contain no Mayari pig-iron at all. The second charge, separated from the first one by twice the amount of coke needed, or using a ratio of 5 to 1, instead of 10 to 1, contained 10 per cent. Mayari pig-iron. The third charge had 15 per cent. Mayari, and was similarly separated from the second charge. The fourth charge had 20 per cent. Mayari iron, in similar manner. Where a fifth charge was run, this consisted of whatever mixture was found convenient, usually with steel to reduce the total carbon. It will be seen, therefore, that the charges were much more widely separated than would have been the case in charging the same mixture repeatedly, and, therefore, melting could be expected to be fairly separate. It was only after the trial was made in foundry after foundry that resort was had to the crucible department of the Bethlehem Steel Company, which generously detailed an entire unit of its large regenerative furnaces, holding 24 crucibles at a time, for this purpose.

In order to have the results as comparable as possible, even the scrap used was first made by remelting a standard pig-iron in 5-ton batches. A mixture of 60 per cent. pig and 40 per cent. scrap was used in every case, the Mayari pig-iron forming part of the pig, when it was used. The laying-out of the mixtures need not be gone into here; it is sufficient to say that every effort was made to have the programme as exact as this could be made consistent with ordinary foundry routine. The charges varied from 600 to 2,000 lbs. each, depending upon the cupola of the particular foundry. The surplus metal went directly into castings. Two sets of cores arranged for three test bars each were poured off for each mixture, the cores being parked together and rammed up in a flask. The A. S. T. M. arbitration bar, 1¼ in. dia., and 15 in. long, poured vertically, was used, being afterward tested for transverse strength and deflection on supports 12 in. apart, for tensile strength, and for hardness by the Brinnel test. Micrographs also were taken. A complete analysis was made for each set of bars of a mixture.

The following figures summarise the results:—

Charge No.	In Mixture Ni.	In Mixture Cr.	In Castings Ni. Aver.	In Castings Cr. Aver.
1	0.00	0.00	0.10	0.23
2	0.12	0.24	0.11	0.28
3	0.18	0.36	0.10	0.27
4	0.24	0.48	0.10	0.28

From this table it will be observed that with perfect bed conditions in each of the four foundries, "first iron" over the spout coming in 10 minutes in each case, and with twice as much coke between the charges as need have been in ordinary practice, yet the Mayari pig-iron must have melted (and the other pig-irons—also machine cast—with it) from the upper charges before the lower ones were gone. The above figures are the averages of a series of melts in each of which the regular progression of charges contained the nickel-chromium content as stated. What would have been the result had the usual 10 to 1 ratio of metal to coke been used can only be conjectured. Melting could not have taken place within the middle of the upper charges as the only oxygen likely to be pre-

sent above the melting zone would be close to the lining of the cupola. That melting does take place far up in the cupola at the lining is often observed by the foundryman when the nature of the scrap keeps the charges open. Thus, in making brake-shoes with heavy percentages of stove plate scrap, and where on occasion an entire stove finds its way into a charge, iron can be observed melting a foot or two below the charging door, with the entire rim of metal red hot.

The only conclusion to be derived is that melting takes place much higher than is supposed, along the lining, and that it is of utmost importance to charge metal and scrap uniformly in their several layers, so that whether melting takes place in the upper charges or not, whatever does drop down will consist of the right proportions in the mixture. Again, that strict attention be paid to the order of charging—steel first, pig and heavy scrap next, and light scrap on top. Machine cast pig melts faster than sand cast pig of equal sections, because of the higher combined carbon in the first. Inasmuch as machine cast pig usually has a heavier section, this condition of melting usually equalises itself.

Further, the practice occasionally met with of placing all the pig of a mixture around the rim of the charge, and the scrap in the centre, cannot be condemned too severely. Cupola melting differs from all other methods in the peculiarity that intense heat is developed at the actual contact point of coke and iron. With the usual layering in charging, the proportion of coke to pig iron at the rim with the above mentioned practice, will be considerably smaller than it is in the middle, and hence coke will burn away too fast around the sides to give very hot metal, not to speak of it being oxidized. If it were not for mixing with extremely hot metal from the central portions of the cupola when the tap-hole is opened and the metal converges from all parts of the crucible, bad results would be had. As it is, many cases of alternating hard and soft castings, which look sound and have blow-holes side by side, can be traced to this bad practice when other charging conditions are correct.

Therefore, it can be emphasised that with all its advantages the cupola melting process has some draw-backs, one of which is plainly shown by the tests with nickel-chromium here described. Every attention must be given to the details of charging and blast conditions, so that however melting will consist of the right proportions in the mixture.

Major G. Fetherston, D.S.O., M.C., His Majesty's Trade Commissioner at Cape Town, is in attendance at the Department of Overseas Trade for a brief period, and will be pleased to interview manufacturers and merchants interested in trade with South Africa. Appointments with Major Fetherston can be made by application to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. The reference, 3932/T.G., should be quoted in all cases.

Electric Scaling Hammer.—An interesting demonstration of the Sandblom electric scaling hammer took place recently at the shipyard of Messrs. John Stewart & Sons, Limited. The efficiency of the hammer as a labour-saving device was amply proved by the removing of rust from the hull of a vessel on the stocks in one-sixth of the time taken by the hand hammer. The electric hammer weighs about 26 lbs., and consists of a hollow shaft through which a spindle revolves. At the head of the spindle a number of two-link chains with hammerheads are attached, and when the small electric motor coupled to the spindle is started the chains are thrown outwards by centrifugal force. The revolving spindle with its hammers is held so that the hammerheads come into contact with the surface to be scaled. The hammer can be handled by one man. It provides a rapid and efficient method of removing scale, rust and old paint from iron and steel work, such as bridges, boilers, etc. It is specially adapted for the cleaning of surfaces badly corroded and pitted, the small hammerheads following and entering all indentations and cavities and cleaning them thoroughly. One great advantage is that, where the hand hammer and the pneumatic chipper both leave cuts and indentations in the plates, the electric hammer leaves a smooth surface, and little, if any, brushing down is required before paint or other coverings are applied. The manufacturers are the Electric Scaling Hammers, Limited, 6, Broad Street Place, London, E.C.2.

Old Methods and their Present-Day Application.

By Ecossais.

Although plaster of paris is used freely in many foundries, there would seem to be still plenty of founders who do not realise its usefulness, and this notwithstanding the numerous articles and papers and demonstrations relating to its use.

It is proposed to deal chiefly, however, with the use of plaster for pattern-plates, for jobs which can only be mounted or cast on plates with difficulty. The chief advantage of cast-metal pattern-plates over mounted patterns, in the case of the same pattern, is the greater speed of producing it and its lower cost. When the pattern is of such a shape as to require a joint approaching right angles to the horizontal or box joint, the cast plate is out of the question, and with any steep angle the thickness of metal in this portion of the plate is much less than that of the body of the plate. With cast iron, even if the plate casts satisfactorily, there is always the possibility of early fracture. Aluminium might be used, but there are certain disadvantages in its use for plates, even if the shrinkage has been overcome and beeswax has not been required in quantity, unless kept well varnished or warm enough not to cause tearing and "clagging," due to its natural coldness.

With a pattern of a delicate design such "clagging" would, of course, necessitate knock-outs. If wax had been used, warming the pattern, unless very carefully done, will melt the wax and mean repairs. To overcome the steep joint in mounting as against casting on a plate, two

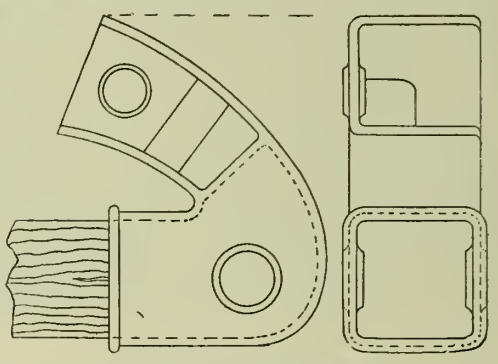


Fig. 1.—Illustrating a Method where Plaster Matches can be Advantageously Adopted.

plates, or a very thick plate, would be required, which would be so heavy as to mean wood being used instead of metal. By using plaster and casting a match on the top-box of a mould and one on the bottom box, with or without removal of pattern, two "plates" are available in a very short time, the steep joint presenting no difficulty, and showing the advantage that both parts can be worked simultaneously. This is, of course, not possible with a two-sided or ordinary type of plate.

It is frequently argued that plaster is easily damaged and marked, but with ordinary care it can be made to serve for a long period, alterations can easily be made and slight damage quickly repaired. When it is desired to work from plaster for a large order it is advisable to cast around metal patterns in both top and bottom box, provision being made by projections or screws for holding to the plaster cast around them.

White Metal Patterns.

A cheap, white metal is very suitable for the patterns, being easily filed up, and unlike iron or aluminium in that it does not rust or oxidise in the damp and steam prevalent in the foundry. In the event of a new plaster being required an impression can be taken off each part at the end of the day, the metal patterns from the old plaster put in position, cast, and washed when sufficiently hard, being varnished the following morning, although this may be done the same night within 2 hrs. of the plaster being cast. To hurry along the drying a light "brush-over" with methylated spirits will help, and by putting the "plasters"

in a draughty place, found in most foundries, the spirit will accelerate the evaporation of the surplus water. Drying in the stove is sometimes resorted to, but, in the writer's opinion, this weakens the plaster and shortens its life. So far as durability of plaster is concerned, this never gave much trouble to the writer, as patterns rarely had a run of over two months before becoming obsolete, being replaced by others of fresh design. Certainly in this case it was inadvisable to make expensive plates, and there was no difficulty re storing, as plasters were in commission for regular quantities right up to the times when superseded by the patterns of new design. In certain jobs which were worked with loose pattern, a plaster oddside with white metal gate patterns was used, this saving joint making and ensuring correct gating, as otherwise, owing to operators being on iron, aluminium, bronze or brass at different times, there was a tendency to err in the size of the different gates and lumps provided on them for feeding and skimming purposes. The method of making the gates was to make a complete mould and cut out the gate with care, replacing the patterns, and casting the gate right up to the patterns, with the top box in position. The top was afterwards removed, the gate carefully lifted and trimmed and replaced in position, plaster being cast around this and on the patterns in the bottom box in the frame used for the oddside. In use, the gate was left in the correct position on removal of the oddside after ramming up the bottom box.

In many cases, by using a wooden or even a metal frame for both cope and drag, match patterns can be made to leave their own cores in the correct position, with the metal thickness exact.

Sump Castings.

A case in point is the sump casting or lower half crank-case for motor-cars, usually cast in aluminium. Some foundries use a solid, or block pattern, and provide coreboxes for making the cores, usually green-sand. If the cores are not sitting sufficiently low, due to tight prints, the metal at the top will be too thin, or even mis-run, or, again, the core may be tilted over slightly. If the prints fit too easily the cores are always liable to be more or less eccentric, and the space between print and core requires making-up if extra chipping is to be avoided. This double-match method was also adopted in several other cases where there is a delicate wooden shell pattern liable to get distorted. With a wooden shell pattern, even if well varnished, and supported by a wooden block, the pattern is given every opportunity to warp, as one side is moist by contact with the sand and the other next the block kept practically dry. In such cases it was the writer's practice to make a complete mould of the pattern as soon as possible after receipt of the pattern, and cast two matches with the pattern removed. If a metal pattern was required, and double contraction provided in the original pattern, this was made first and the plaster made from this after being finished. As by making a metal pattern some little time is taken up before the job gets into commission, the procedure adopted by the writer in all urgent cases was to get the patterns made with one contraction and, if necessary, the job could be worked off in 2 or 3 hours' time. Among the jobs dealt with in this manner were small propeller fans for radiator cooling purposes, light boxes, both open and closed ends, light machine guards and small motor ends, small switch boxes and lids, and the panels in machine-tool sides. Another case where plaster saved some expense and delay was by the casting shown in the two views in Fig. 1. The job was intended to be cast in malleable, and to cover the time required to get deliveries from the malleable foundry a stock was worked up in bronze, and the patterns despatched by passenger train to the malleable castings concern. When the stock had been practically exhausted it was discovered that the patterns had never reached their destination, having been lost in transit. This meant new patterns and another long wait for deliveries. Whilst the patterns were being made a scrap casting was found, the core-print plugged with a print, and a couple of plaster matches cast, dressed and varnished 3 hrs. after the discovery of the loss of patterns. At the same time a core-box was cast in white metal in two halves on one of the cores, remaining from last order, with lugs to match for dowel pins. After drilling the lugs the box was parted, and cores rushed into the stove. By the time the moulder had made about six moulds his cores were ready, and two hours later six castings were delivered, followed by other deliveries at two hours and one-hour intervals. This was followed up the following day by larger quantities, as there were then plenty of cores available, and the situation was saved. This would have been almost impossible loose pattern, and certainly not by working from an old casting.

World's Output of Electric Steel.

Except in two or three countries practically no electric steel was made prior to 1913. In the United States, Germany and France, particularly the two latter, electric furnaces were making steel as early as 1908 and 1909. The industry, however, did not attain any magnitude until 1913. In that year Germany was its acknowledged leader.

Due to the stimulus of the war, the electric steel industry of all producing countries expanded until the peak was reached in 1918, when, according to "The Iron Age," over 1,140,000 tons was produced against only 168,600 tons in 1913. In this period, however, the United States gradually displaced Germany from the lead, with an output in 1918 nearly equal to that of the seven other producing countries combined. The output in 1915 was about 80 per cent. greater than in 1913, while in 1916 it was about 90 per cent. greater than in 1915. From 1916 to 1917 the increase was about 50 per cent., and from 1917 to 1918 the expansion was about 40 per cent.

In 1913 Germany produced over 50 per cent. of all the electric steel then made. Although the United States ranked second in that year, the industry had only just started. Germany and Austria-Hungary were credited with close to 70 per cent. of the world's output in 1913. But by 1918, although Germany had increased its electric furnace production about 2½ times, the United States output had expanded 17 fold. Their output was not only twice that of the two so-called Central Powers, but was nearly half the total of all the producing countries. Another feature of the development of this industry up to 1919 was the rapid growth of the British and Canadian production. In 1913 there is no record of any output in those countries, but in the four years 1915 to 1918 inclusive, the British electric-steel industry had expanded five fold and the Canadian about 21 fold.

The progress of the industry as a whole in the readjustment period since the war, or in 1919, 1920 and 1921, has varied with the peculiar conditions existing in each country. Despite the falling off, the 1919 total for six countries was larger than the 1916 total for eight nations. The 1920 total for six countries, assuming Germany to have made as much as in 1919, exceeds the 1917 output for eight. In 1921, the year of world-wide depression and strikes, probably over 425,000 tons was produced by the six countries, including Germany, or a figure nearly equal to the output of 1913 and 1915 combined. The following table excludes any post-war returns from Germany and Austria, figures not being available:

Output of Electric Steel Ingots and Castings in the Leading Countries in Tons.

Country.	1913.	1920.	1921.
United States ..	30,180	502,152	169,499
Germany	88,256	—	—
Great Britain ..	None	89,100	27,100
Canada	None	28,301	16,844
Austria-Hungary ..	26,837	—	—
France	21,124	58,080	24,457
Italy	—	*100,000	*140,000
Sweden	2,276	—	—
Total	168,673	777,633	377,900

* Estimated.

The Trend of American Specifications for Steel Castings.*

By E. R. Young.

One of the mooted questions in the steel industry and one which concerns the steel-casting manufacturer is the question of the limits of phosphorus and sulphur. Earlier specifications set these limits at 0.050 per cent. for acid open-hearth steel, and these were commercial up to the time of the war demand. When fuel and melting materials which would yield a finished product under these limits became difficult to secure and were needed for types of steel in which low phosphorus and sulphur were of vital importance, the phosphorus and sulphur limits for steel castings were raised to 0.06 per cent. for acid steel. These limits were tentatively continued in 1919 and were adopted as standard in 1921 by the American Society for Testing Materials. Some purchasers, however, are still loath to adopt this new limit. The findings and recommendations of the joint committee on phosphorus and sulphur in steel which is now making an exhaustive study of the subject will undoubtedly prove the limits of 0.06 per cent. to be entirely proper for steel castings and will probably justify a more liberal limit. It is to be hoped that this report, when forthcoming, will be of such a nature as to be conclusive on the subject and that it will be accepted as standard by all.

The objection of the average engineer or metallurgist to steel with phosphorus and sulphur over 0.05 per cent. or 0.06 per cent. is based partly on tradition and partly on a mental reservation regarding the shock strength of the material. It is this objection to phosphorus and sulphur based on tradition or perhaps even on prejudice which the findings of the joint committee will surely answer.

Table I.—*Comparative Tensile Properties of Heats.*

Classification of Heats.	Physical Properties.					Analysis.				
	No. of heats.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	Elongation. Per cent.	Reduction. Per cent.	C.	Mn.	Si.	P.	S.
Heats high in sulphur (0.070 or above)	209	20.0	35.7	22.4	28.7	0.29	0.71	0.30	0.045	0.076
Heats low in sulphur (under 0.055)	110	20.1	36.6	22.2	29.0	0.30	0.70	0.30	0.044	0.052
Heats high in phosphorus (0.055 and above) ..	32	19.5	36.1	21.7	28.0	0.30	0.72	0.31	0.056	0.061
Heats low in phosphorus (under 0.040)	74	19.9	35.8	22.8	29.9	0.29	0.70	0.29	0.037	0.065

Phosphorus from 0.04 per cent. to 0.06 per cent. and sulphur from 0.05 to 0.07 per cent. do not affect the static properties of annealed steel castings, that is the properties determined by the usual tensile and bending tests.

The writer has the data on the physical properties and chemical composition of 1,036 heats of ordnance steel (cast steel No. 2 and No. 3 U.S. Army specifications) made by the converter process, which has been analysed to detect any variation of tensile properties with the phosphorus or the sulphur content. Four divisions or classes were made as is shown in Table I.

The heats were segregated according to this classification and the average tensile properties and chemical composition of the heats in each class were computed. Table I. gives the average properties and composition, and the number of heats included in the average in each case.

The average properties show a sensitive relation to the carbon and manganese content as would be expected. There is no suggestion of any relation to the phosphorus or the sulphur content with the possible exception of the value for yield point for the high phosphorus heats which is slightly out of line with the other average properties for these heats. This is very likely due to the average including a relatively small number of heats, and so, being unduly affected by a few low values; but, in any event, the decrease is well within the limits of error of testing and therefore unimportant.

Results of a short series of impact tests have been published which show a marked falling off in dynamic or shock strength, between 0.06 and 0.07 per cent. phosphorus.† However, considering the somewhat uncertain standing of this test in the field of testing materials and, especially, the small number of tests included in the average results, it does not seem that this evidence on the subject can be regarded as final.

The writer has seen screws, bolts, etc., made of screw stock with phosphorus and sulphur both over 0.10 per cent., tested to destruction, without any weakness of material being disclosed. He has also seen steel castings with phosphorus over 0.06 per cent. and sulphur over 0.075 per cent. tested to destruction with no suggestion of weak or faulty material, though the uninitiated would confidently expect such tests to show the material to be decidedly inferior.

The final answer to the question of shock strength is the test of service. Perhaps there have been cases of failure of steel castings used under severe shock conditions, which have shown a high content of phosphorus and sulphur in the broken parts. Supposing that these failures have been shown to be due to faulty material and not to foundry defects or to excessive loading, the remedy is still not lower phosphorus and sulphur, but proper heat treatment. In the writer's opinion this has been conclusively shown by the work of Mr. John H. Hall and associates on the "Heat Treatment of Steel Castings."‡ They have shown that the lines or planes of weaker material, due to the non-uniformity or segregation promoted by phosphorus and sulphur, can be removed by quick cooling from the annealing heat, followed by reheating at the proper temperature, but cannot be prevented from forming slow cooling from the annealing heat, by any lower content of phosphorus or sulphur down to 0.025 per cent.

Further evidence that an extremely low content of phosphorus and sulphur is necessary before any gain is made in the properties of carbon steel is given in an article detailing the practice of the U.S. Naval Ordnance Plant at Charleston, W. Va., by W. J. Priestley.¶ He shows that an increase in the figure obtained for reduction of area on tangential test bars occurs when the phosphorus and the sulphur content are reduced below 0.020 per cent. If we agree that reduction of area is a rough index of toughness and that the usual conception of shock strength is of

* Extract from "The Blast Furnace and Steel Plant."

† F. C. Langenberg, "Impact Tests on Cast Steel," Proc. A. S. T. M., 1921, page 810.

‡ "Heat Treatment of Steel Castings," Amer. Inst. Min. and Met. Engrs., Vol. LXII., page 353.

¶ "Sulphur and Oxide in Steel," American Inst. Min. and Met. Engrs., February, 1922. "Iron Age," December 29, 1921, page 1658.

a property which combines toughness with good elastic limit we conclude that an improvement in shock strength is not achieved by a reduction of the phosphorus and sulphur content from 0.060 to 0.025 per cent.

It is gratifying to note that recent U.S. Army specifications for caterpillar tractor links or shoes permit sulphur to 0.07 per cent. and specify a heat treatment consisting of a straight anneal followed by a water quench and tempering. The tensile properties specified could readily be obtained with a simple annealing treatment indicating that the object of the heat treatment was to improve other than tensile properties.

Occasionally it is intimated that published articles and researches dealing with the question of phosphorus and sulphur are not written entirely in good faith as technical articles, but are perhaps inspired by commercial considerations. It is certainly quite clear that any producer of steel who resorted to propaganda to market an inferior article which would not function properly would be pursuing a very short-sighted policy indeed. It is equally clear, on the other hand, that any user of steel who unnecessarily insists, through ignorance or prejudice, on a costly and relatively less common product is pursuing an uneconomic policy both personally and industrially.

Physical Properties.

One of the frequently proposed revisions in physical property specifications is to require a reasonably accurate determination of the elastic limit, and to make this property, together with the usual ductility requirements, the basis for acceptance or rejection, the ultimate strength to be reported only as an item of information.

At first thought, this plan sounds very good. It is argued that the elastic limit is the property in which we are most interested. It is the property that has been used as the basis for design and it determines the point of failure in service more often than does the ultimate tensile strength. This is all true, but there are difficulties in the way of adopting this suggestion. One difficulty is that of definition, and another that of method. When we come to the question of an exact definition of the proportional elastic limit or proportional limit (which is the property commonly determined in actual testing and which closely corresponds to the elastic limit based on permanent set) and a method of determining it in practice, we find we have nothing hard and fast for a standard. Authorities on the testing of material state that the greater the refinement of measurement and the greater the delicacy of instruments used in determining the proportional elastic limit the lower the value obtained for this property.

Granted this situation is not peculiar to steel castings, but applies to other materials similarly tested. However, most of these materials, when subjected to the standard tensile test, show an almost constant stress-strain (load-stretch) ratio within the elastic range and a definite break from a straight line in the stress-strain curve which for practical purposes it is satisfactory to take as the proportional elastic limit. Actually the value obtained here is higher than that obtained in tests of greater precision and more nearly represents the yield point, which is defined as the stress at which there is a marked increase in rate of stretch with no increase of load.

Steel castings, on the contrary, do not show a constant cross-strain ratio. The amount of stretch under uniform increases of load is very irregular and the stress-strain curve is far from a straight line from its very beginning at the point of initial load. And so there is, of course, no one point where the proportionality of stress to strain shows a marked change, i.e., no true proportional elastic limit.*

Hence, for steel castings it is not feasible to specify the elastic limit and to require its determination by the usual stress-strain curve method. The alternative is to specify the yield point and to require a more accurate determination of it than is secured when the beam of the testing machine is used as an indicator. One satisfactory method of securing greater accuracy is to use an extensometer to detect the point of greatly increased rate of stretch. Another is the method of striking an arc on the chalked or smoked surface of the specimen and watching for the first visible widening of this arc. Both of these methods are quite workable and give a close indication of the actual yield point.

The usual determination of the proportional elastic limit, as has been noted, also actually gives a close measurement of the yield point, so there is no difference in the physical property measured and little difference in the value obtained under the two different requirements (where applicable). But while there is no difference in final results there is a difference in the properties originally specified and in the method of test contemplated in the specifications. It is highly desirable that both manufacturer and purchaser realise just what properties and characteristics of the steel it is the intention to establish under test and just what the properties are, which are actually determined in the prosecution of the test.

The fact that an elastic limit specification is not readily applicable to steel castings has been taken account of in some recently proposed revisions, which specify a minimum yield point instead of a minimum elastic limit, when the tensile strength specification is omitted.

Ductility Specifications.

The new manner of specifying the ductility requirements, i.e., in terms of the tensile strength or of the elastic limit or yield point is coming into more general use. The tensile strength is the more satisfactory to use for steel castings because it can be more exactly determined and because it shows a more uniform relation to the other properties. The new specifications state that the per cent. of elongation and the per cent. of reduction shall be equal to certain constants divided by the tensile strength, with a fixed per cent. of elongation and a fixed per cent. of reduction required as a minimum for each type of steel. The intention is, seemingly, to take into account the inverse relation which exists between the tensile strength and hardness of steel on the one hand and its ductility on the other hand, and the change from the former method of specifying a definite percentage of elongation and a reduction for each class of steel regardless of strength, is very logical. But when we come to examine the percentages required as a fixed minimum we find, in some specifications, that they are set so high as to correspond to the ductility of the softest steel in each class.

The sliding scale set up by the formula thus becomes inoperative over almost its entire range, because the value obtained by its use is always less than the fixed minimum. In a few cases where the tensile strength is unusually low relative to the yield point, which is up to the requirement, the scale might operate. The result would be, of course, a higher ductility requirement for the steel in question than the fixed minimum.

The net result, then, is to raise the ductility requirements. This would not be objectionable in itself if it were the end sought and were thought necessary. But after recognising the fact that for two steels of the same general class the one with the higher tensile strength and hardness will be less ductile than the one with the lower tensile strength and hardness, and this with no sacrifice of quality, it is illogical to turn about and say that the stronger steel must nevertheless show the ductility expected of the one of lower strength.

New Methods of Test.

Of late much more attention is being given to the strength of materials under repeated and reversed stresses and to methods of determining this property of resistance to fatigue.

Some very interesting data have been published covering the fatigue strength of ferrous metals in the rolled condition.* While cast steel probably has different fatigue properties from rolled steel, it is likely that some of the general facts established regarding the relation of fatigue strength

* Lawford H. Fry, "Tensile Properties of Steel Castings," Proc. A. S. T. M., June, 1922.

* H. F. Moore and J. B. Kommers, "An Investigation of the Fatigue of Metals," Bulletin 124, Engr. Experiment Station, University of Illinois.

to other properties will prove true for cast material also.

It was found that the ultimate tensile strength bears a closer rolation to the fatigue strength (endurance limit) than does the elastic limit; that neither the ultimate tensile strength nor the elastic limit have a sufficiently close relation to the endurance limit to justify their use as an index of the latter; that of the tests more commonly used, the Brinell hardness test bears the closest relation to the endurance limit and gives the most promise of serving as an index of it.

The fact that the tensile strength shows a distinct relation to the endurance limit and that the elastic limit does not, may serve to modify the present estimation of the relative importance of these two properties. With regard to cast steel, this information is particularly pertinent because, as we have seen, cast steel has no true elastic limit, while its ultimate strength is a very definite property.

Brinell Testing.

The use of the Brinell hardness test is steadily increasing in metallurgical testing because of its ease of execution and dependability and the significance of its results, especially when the action of certain material or heat-treated part, under the Brinell test, has been previously studied. For these reasons, in cases where the material is subject to 100 per cent. test and inspection, the Brinell test is frequently specified by giving the limits of hardness desired. Now that some indication of the fatigue properties of the metal is also obtained by this test it will undoubtedly be employed to a still greater extent.

Brinell testing of steel castings has been done to a limited extent, largely for specific information as to hardness. The difficulty of applying the test to large pieces is an objection not easily overcome. It may be that the portable Brinell could be utilised for this purpose, though so far as the writer is aware this adaptation of the Brinell test is not nearly so well standardised as is the regular method.

Another serious objection would be the influence of minor surface defects or non-uniformity on the Brinell tests. On the other hand, we have the present method of judging the annealing of castings of various sections, by the visual examination of the fracture of an annealing lug with a section of ½ in., which it is readily admitted is a far from ideal method. In most cases where annealing lugs are used the inspection by means of their fracture is a 100 per cent. operation and the Brinell test could be applied with no greater consumption of time.

With the larger use of heat-treated castings which is surely coming, the Brinell test will undoubtedly be quite commonly specified.

Alpax—A New Aluminium Alloy.*

By M. de Fleury.

[Abstract.]

Known under the name of "Alpax" in France and the States, and by the name of "Silumin" in Germany, a new aluminium alloy has opened up many novel applications which have been set forth in the technical Press of the world. In all probability the extension of its utilisation will be extremely wide, for the new product fills a real need.

Basically it is a light foundry alloy, possessing high strength, and is not fragile, thus filling a need which is at present felt in the metallurgy of light alloys.

Duralumin possesses properties which are remarkable in many aspects, but only in the rolled or forged state, after having been quenched and tempered. In other words, as cast iron is to mild steel so is this new metal to duralumin, because alpax possesses excellent qualities in the cast state.

The composition of the alloy does not present from the theoretical point of view any novel characteristics. It is simply an alloy of 13 per cent. silicon and 87 per cent. aluminium. It is the eutectic point of the aluminium-silicon binary system. As is well known, a 13 per cent. silicon-aluminium alloy prepared in the ordinary way is fragile, of large grain, and is inferior to most alloys. However, a special treatment in the crucible gives it special qualities. This treatment was discovered by Dr. Pacz, the inventor of alpax, and has been set out in a series of patents which have been bought for France and America by the Compagnie des Produits Chimiques et Electro-Metallurgiques d'Alais, Froges et Camargue, and the Société d'Electro-Chimie et d'Electro-Métallurgie, and in Germany by the Metallurgische Gesellschaft, of Frankfort.

The treatment apparently consists of a physical and chemical refining, by means of alkaline salts.

Unfortunately, the theory of Dr. Pacz's reaction is not clear. It does, however, give an extremely light metal, which is fibrous, not fragile, and distinctly elastic.

The new metal presents the following characteristics:—

(1) It possesses a specific gravity of 2.64, which is 10 per cent. less than most ordinary aluminium foundry alloys. It has one-third the density of steel.

(2) Its resistance to atmospheric disintegration is at least equal to that of pure aluminium; that is to say, it is distinctly superior to normal aluminium foundry alloys.

(3) It produces perfectly sound castings, which allows of the manufacture of water-cooled monobloc cylinders with the greatest ease.

(4) Its contraction is not greater than that of cast iron, and is distinctly less than ordinary aluminium alloys.

(5) It is not fragile during its solidification period. This property, considered with the ones mentioned above, permits of the manufacture of the most difficult and complicated castings without any appreciable loss through wasters.

(6) The guaranteed tensile strength is 12 tons per sq. in. minimum, with an elongation of not less than 5 per cent., with the supplementary condition that the tensile strength, expressed in kilos. per sq. in., plus the elongation shall be greater than 25. These are mechanical results which are absolutely novel, and constitute a revolution in the use of light foundry metals.

(7) The breaking point of alpax at high temperatures (300 deg. C.) is greater than other aluminium foundry alloys.

(8) Finally, attention should be drawn to the use of alpax for castings subject to wearing.

Its application in the future, say within three or four years, in the motor-car industry should be trebled, providing the same number of cars are manufactured. It is possible to visualise motor-cars which will be comfortable, extremely light, speedy, and running with a lower petrol consumption than modern makes.

The immediate application of alpax includes the following: wheels, brakes, monobloc cylinders, pistons, connecting rods, and carriage work.

In order to realise the large margin of possible lightening, it may be stated that the simple substitution of the castings utilised in a cycle-car weighing 770 lbs. would allow the weight to be lowered by 132 lbs. without damaging the solidity nor the upkeep of permanent ways. A motor omnibus can be lightened by 550 lbs.

For ship construction alpax could be used for large Diesel engines. It is obviously particularly interesting for submarines and aviation.

Briefly, alpax can substitute steel castings where lightness is an essential. In railway construction in Germany alpax has already been used as a substitute for bronze in the manufacture of axle boxes, but this question is associated with the importation of copper.

The question has been dealt with in a more detailed form in a Paper which he read before the Société d'Encouragement, and published in their Bulletin No. 7, and also an article published in the May, 1922, issue of Revue de Métallurgie.

* A Paper presented before the Association Technique de Fonderie—the Nancy Conference.

BLAST VOLUME.—In this article, which appeared in our issue of August 31, two errata crept in. In col. 1, line 31, "add should read "all," and in col. 2, line 31, the square root sign has been omitted over "head of water in inches."

Making Electric Steel Castings.

By L. T. W.

The electric furnace is very suitable for the manufacture of steel castings, especially those of light and intricate nature, owing to the fact that it involves no temperature difficulties. The cost of production, if the furnace is worked continuously and cheap power is available, is fairly low. Cheap raw material can be used, consisting of rivet heads, punchings, turnings, etc., which can be refined and made into first-grade steel. The purity of the steel is unquestionable and the composition required is easily obtained, but whether low-phosphorus and an intensive deoxidation acts against fluidity is sometimes disputed.

Physical Properties.

Another important feature is that good mild steel can be made which, unannealed, will give mechanical tests to meet the demands of "British Standard Specifications" for ordinary castings, and castings made from such steel, if not intricate, may safely be despatched without annealing; but all intricate work and castings, to stand severe pressure, should be subject to heat-treatment, to remove all strains and casting structures.

The furnace should be run by a skilled and intelligent operator, for much depends upon the condition of the slags and the temperature, especially during the refining period; the writer prefers the services of one having a good knowledge of the chemistry of the process.

A Typical Heat.

Below will be found a description of a typical heat of mild steel, made in either a 2-ton "Electro Metals" or "Greaves-Etchell" furnace, working with two electrodes on 3-phase current at 85 volts, with an average of 3,500 ampères on each electrod phase.

The working of an electric furnace differs considerably from all other processes, the refining being accomplished both by oxidising and reducing conditions. The operations are divided into two complete parts, first, the reduction of the C., Si., Mn., and P. to 0.08, 0.03, 0.06 and 0.007 per cent., or thereabouts, respectively. Secondly, the reduction of the S. to 0.01 to 0.02 per cent., and also oxides left in the bath from the previous operation.

As in basic open-hearth practice, it is necessary, in order to remove the phosphorus from the charge, to reduce the carbon to the low percentage indicated.

Assuming the furnace to be hot from the previous cast, it is fettled as is found necessary. Obviously the slag line requires most attention; this is repaired with burnt dolomite, crushed, in the author's practice, to pass through a ½-in. or ¾-in. sieve, but some overloaded furnaces use the dolomite retrieved from banking up to increase the capacity. If the hearth is low, lime may now be charged on to the furnace bottom, followed by a little iron-ore, but, if high, it is advisable to mix with the charge, always being careful not to insulate the charge or hearth. Then a good layer of turnings or punchings are added, and, if runners, feeding heads, or "rejects," form part of the charge, these may be thrown in next, followed by another substantial layer of punchings. It is advisable to make the charge as dense as possible, as this will assist the current to pass directly through to the neutral return incorporated in the furnace hearth. Should the material used for charging be coated with rust, less need be added as sufficient oxide will be present for the oxidation of the charge.

The charging being complete, the current is switched on, and the electrode gear is operated by hand until a steady load is obtained; then the automatic switches may be brought into use. During the melting period more lime, and sometimes fluorspar and silica sand, are added to form a slag. This slag is maintained very fluid, and contains an excess of oxide of iron, which oxidises the carbon in the charge to form carbon monoxide; this, rising through the slag, gives the appearance of boiling. At the same time the silicon, manganese and phosphorus are also oxidised.

By taking a small spoon-sample of the molten metal, and examining it for either fracture, spark or bending, the operator is usually able to give a fair estimation of the carbon of the bath, which, if too high, more iron-ore should be added and time allowed for the reaction.

When the charge is well-oxidised and sufficiently hot, the oxidising slag is then removed. The furnace is tilted, and a part of the slag runs off; the electrodes are then raised well above the metal and the remainder drawn off with rakes (preferably wooden ones), so that the surface of the metal is practically clean. The furnace is then returned to its normal position, and the bath, recarburised to the desired degree with powdered anthracite, gives very consistent results; its action is rapid, and it gives from 50 to 60 per cent. efficiency. The anthracite, if too large, will not quickly disseminate, and, if too small, will agglomerate.

Reducing Period.

Either before or after recarburising, ferro-silicon is added, in lump form, in the proportion of about 10 to 12 lbs. of 50 per cent. ferro-silicon per ton of steel in the furnace (0.20 per cent. Si.); a new slag is then made up, consisting of lime, sand and fluorspar, and the current switched on.

As soon as the metal is sufficiently hot a sample is taken for carbon analysis, and meanwhile the process of refining proceeds.

Since the phosphorus has been practically removed, and since there remains in the steel the bulk of the sulphur and a large percentage of iron oxide, arising from the pre-slagging conditions, conditions must be instituted for their removal. The deoxidation of the metal is effected chiefly by the inter-reaction of ferro-silicon, generated calcium carbide, and the ferrous oxide. Whilst not theoretically correct, one can imagine that, whilst the bath is as still as a mill-pond, the sulphides of iron or manganese, having a lower specific gravity than liquid steel, rise to the top and are absorbed by the high-lime slag.

Sulphur is found by some to be difficult of removal from a low carbon bath, for the reason that it is difficult to kill, and sulphur will not leave a wild bath. It appears that there is only a small temperature range in which it is possible to kill low carbon steel. Thus, it is often necessary to lower the temperature to effect the killing. By this means the author obtains consistent results, which show that, with the carbon content as low as 0.20 per cent., the sulphur and phosphorus can be reduced to 0.01 or 0.02 per cent. in practically every case. Such practice is necessary in making stainless steel and iron and other alloy steels.

When treating the slag with powdered anthracite caution should always be used, for, if an excess is added, a dark grey slag, loaded too heavily with calcium carbide, will be obtained, resulting in a high carbon percentage.

From time to time small samples of steel are taken from the bath to ascertain the condition of the metal; the first one or two may appear "wild." If this is so, lump ferro-silicon should be added, in the proportion of about 2 lbs. per ton of steel, after each sample, until one is obtained which solidifies without rising, time having been allowed after each addition for the reaction. The temperature should also be adjusted until dead. Once dead, it can usually be raised without destroying the equilibrium temperature, and a good frothy slag maintained. Thirty to thirty-five minutes should be ample time for refining, and the final additions may then be made.

If the result of the analysis shows the carbon to be low, Spiegel and/or ferro-manganese is added to give the required percentage, and also to raise the manganese to the desired degree; then in a few minutes the steel is ready for pouring.

In some practice, though not altogether too desirable, ferro-titanium or aluminium is used as a final deoxidiser for the steel. If the latter is used, it may be added to the metal in the ladle, but if the former is used, the writer favours adding this to the steel in the furnace, just before pouring, as, owing to the higher melting point of this alloy, the reaction is assisted, being more rapid and complete than when adding to the steel in the ladle. Cases of hard spots have been traced to poor incorporation of ferro-titanium. A good mild steel

of the following composition, poured at proper temperature, will be found to give good results:—C., 0.20 to 0.25; Si., 0.20 to 0.25; Mn., 0.55 to 0.60; and P. and S., 0.02 per cent. maximum.

Unannealed steel of such a composition will give the following mechanical tests:—Maximum stress, 28 to 32 tons per sq. in.; angle of bend, 60 to 90 deg.; elongation, 15 to 20 per cent.

Ordinary or unimportant casting made from such steel might safely be dispatched without annealing, if desired, but work of an intricate nature should always be subject to heat treatment; for very intricate work and for thin pipes and valves, which have to be subjected to severe pressure, the writer recommends a higher carbon steel, which should always be annealed. The following forms a good composition for general work:—

C., 0.25 to 0.30; Si., 0.20 to 0.25; Mn., 0.55 to 0.60; and S. and P., 0.02 per cent. maximum.

Behaviour of Refractories on Heating.

In a Paper on "The Behaviour of Fireclays, Bauxites, etc., on Heating," presented to the Ceramic Society at Birmingham, Messrs. H. S. Houldsworth, M.Sc., and J. W. Cobb, B.Sc., F.I.C., remark that the changes which occur in clays and similar substances on heating are very difficult, and indeed impossible, to follow by purely chemical methods; they have followed others in attempting to derive as much information as possible by a study of physical changes with which chemical changes may be associated.

The methods adopted have consisted essentially in taking the time-temperature curve of a thermo-couple embedded in the specimen and comparing it with the curve given by a second couple placed in some standard reference substance heated alongside it. If at some temperature the former heating curve lags behind the latter, a change involving an absorption of heat is taking place in the specimen, but if at some point the rate of heating of the specimen is greater than that of the standard substance an exothermic reaction is occurring in the test-piece. The authors have prepared a large number of tables and curves, but they do not at the present stage attempt a complete explanation of the results obtained, which awaits the further evidence they hope to be forthcoming from other methods of examination which they are applying. The following points emerge, however:—(*a*) Kaolin and all the clays and shales examined show distinct heat absorption at a temperature of 500-530 deg. C. and heat evolution at a higher temperature. (*b*) This heat evolution occurs at a temperature of 1,060-1,130 deg. C. with pure alumina made by calcining aluminium nitrate at 700 deg. C., but at a temperature lower to an extent of about 100 deg. C. with the bauxites and clays, presumably on account of the impurities associated with the alumina in combination or some form of solution effective for the purpose. (*c*) Most of the materials show heat absorptions at temperatures below 500 deg. C. presumably due to the loss of water from colloid substances. (*d*) The phenomena observed with the clays are not primarily dependent on the presence of silica. They are noticeable with alumina and with a red bauxite practically free from silica. (*e*) For some reason, although alumina calcined at 700 deg. C. and the bauxites and clays show marked heat evolution at about 1,000 deg. C. as noted above, precipitated alumina gave no sign of it. It may be that the change responsible for the heat evolution had occurred with the precipitated alumina before it was heated in the apparatus, but that with aluminium nitrate or silicate the presence of the other material associated with the alumina deferred the change.

In consequence of the continued trade depression, together with the recent rise in the price of coke, Alfred Hickman, Limited, Springvale Works, Bilston, near Wolverhampton, are compelled to curtail their production of pig-iron. They have, therefore, decided within the next fortnight to blow out one of their blast furnaces, either at Spring Vale or at the works of their allied company, Lloyds Ironstone Company, Corby.

Malleabilisation of White Iron.*

By E. Ronceray.

Note on a communiqué issued by E. White and H. E. Gladhill of the University of Michigan.

This Paper is a discussion of researches which have been made in order to determine the relationship of time and temperature in the malleabilisation of white iron. These researches have for their object the determination of the minimum time in which the metal of any definite composition should be held at a certain temperature, together with the cooling speed necessary to bring about equilibrium.

Composition variations change the necessary time of these two periods, despite the fact that in current practice a safety factor so large must be taken that the effect of composition under normal conditions is not important.

The object of these researches is due to the fact that it has been thought that electricity could be used as a heating medium which would allow of very exact control of the operations, and it was imagined that it would be possible to reduce the time to such an extent that the cost of electricity as a heating medium would compare favourably with other methods.

Researches were made with the object of determining the minimum time necessary to obtain a good-quality product under varying conditions of composition and temperature. They have been able, in the laboratory, to reduce the normal heating time, which is 200 hours, to 34 hours. In practice this time would certainly not be sufficient because of the effect of quantity and size, but taking the double or treble, the time would still be very far from the usual 200 hours.

It has been ascertained:—

(1) That rapid heating produces graphite particles which are larger and more irregular than those produced by slow heating. This factor, however, is of small importance.

(2) That the duration of the heating period is determined by the temperature and composition of the metal. This period varies from a few hours at 982 deg. for several hundred hours at 760 deg. It is strongly influenced by small changes in the silicon content.

The carbon combined content at equilibrium conditions varies from 1.20 to 1.25 per cent. at 982 deg. C. to 0.48 per cent. at 760 deg. C. It is only slightly influenced by the silicon content.

3. That the cooling period is principally determined by the silicon content. The higher the silicon content the quicker the cooling.

With east iron containing 0.82 per cent. silicon, the maximum speed of cooling compatible with the maintenance of equilibrium conditions varies from 14 to 20 deg. per hour (926-870 deg.) to 3, 4, or 5 (760-704 deg.). With an iron containing 0.90 per cent. of silicon the cooling speed of 13 to 15 deg. C. (815-760 deg.) can be used.

It is necessary to remember that these results relate to American malleable iron containing very little sulphur and of which the carbon is transformed into graphite and not eliminated as is customary in Europe. This paper is extremely interesting for European foundrymen, who are now studying with great interest the processes which can teach them to manufacture equally well American malleable iron of which the tensile strength and elongation are distinctly superior to European products, so much so that thicknesses much greater than is usual in Europe can be easily produced.

Teeming Drums.

We notice in the foreign foundry Press that ladles are in some places giving way to drums. The drum is mounted on trunnions and geared to tip in either direction. A rectangular opening is cut from the centre of the barrel so as to form two lips. We presume this form has been designed in order to reduce the surface area and so minimise the radiation losses. We can imagine that this type of ladle would work excellently as a receiver.

* A paper read before the Association Technique de Fonderie—Nancy Meeting.

Institution of British Foundrymen.

General Meeting at Manchester.

A special general meeting of the members of the Institution was held on October 7 at the Manchester School of Technology. Mr. Oliver Stubbs presided, and, in opening the proceedings, said the President, Mr. H. L. Reason, much regretted that he could not be present. He had asked that his place on this occasion should be occupied by Mr. Stubbs, as the immediate past-President.

Apologies for Absence.

The secretary, Mr. Hollinworth, read letters of apology received from Mr W. Lambert (Deptford), Mr. R. Buchanan (Birmingham), Mr. H. H. Moore (Loughborough), Mr. H. A. J. Rang (Newcastle), Professor T. Turner (Birmingham), Mr. E. H. Broughall (Coventry), Mr. J. Ellis (London), Mr. H. Bunting (Derby), Mr. F. W. Finch (Gloucester). There was also a telegram from Mr. M. Riddell (Glasgow).

New Rules Approved.

The Chairman said the meeting was called primarily for the purpose of passing the revised rules, necessitated by the Royal Charter granted to the Institution by the Privy Council. They had been drafted by a sub-committee presided over by Mr. Wesley Lambert, the new President of the London branch; they were afterwards submitted to the General Council, and then to Messrs. Sparks, Whitehouse, Russell & Company, the solicitors who drew up the Royal Charter. These gentlemen expressed the opinion that, although they did not exactly tally with the provisions of the Charter, they were near enough to meet the requirements of the Privy Council, and there was no necessity to make any alteration. Any changes required could be made by the Privy Council. The printed draft was now in the hands of the members. There was one omission. In rule 32, section 11, there should be a clause stating that an association was entitled to receive copies of such publications on payment of any prescribed fee, which shall be approximately the net cost to the Institution. That clause was in the old rules, but unfortunately had been omitted, and should be put in. The Branch Council rules did not come into this matter; they were not affected by the Royal Charter. He moved that the rules as presented, with the amendment he had indicated, be approved.

Mr. Carey Hill seconded the resolution, which was carried unanimously.

Mr. O. Stubbs Elected Vice-President.

Mr. Haigh (President of the Lancashire Branch) moved that Mr. Oliver Stubbs be asked to become senior Vice-President of the Institution. He explained that Mr. Jewson, who was elected senior Vice-President, and who, in the ordinary course, would have been President during the year 1923-24, had found that he could not retain the post. In those circumstances the Institution looked to Lancashire to get them out of a difficulty, and it would be met admirably by the selection of Mr. Stubbs.

Mr. Carey Hill seconded the resolution with great pleasure. It was the first step towards prevailing upon Mr. Stubbs to become the President next year, and after the amount of work which he did during his former tenure of that office, although it was only for nine months, it was very kind of him to come again to the assistance of the Institution.

The resolution was passed unanimously.

The Chairman, in reply, said this honour was not of his seeking. Business circumstances prevented Mr. Jewson from giving to the Institution the time needed for the work of Vice-President and President. For his own part he, along with many others, had given much time and hard work to the Institution, and great progress having been made during a very trying period, he was now particularly anxious there should be no going back. Therefore, if it was the wish of the members, he was willing to be President during the year 1923-24 on the understanding that he was not expected to carry through a tremendously big conference, like that recently held in Birmingham. In twelve months he travelled on foundry work over 30,000 miles. He would be very glad if he could do anything more to further the interests of the Institution.

Next Conference to be at Manchester.

Another matter for the members to consider was the question where the next conference should be held. The General Council had decided, very wisely, he thought, to take greater control over the conference arrangements than they had done in the past, and they would be glad to have an expression of opinion from the members as to where the next one should be held.

Mr. Simkiss stated that this matter had been considered by the Lancashire Branch Council, and there was a general feeling that it should be held in Manchester. He therefore moved that the General Council be recommended to hold the 1923 conference in Manchester.

Mr. Haigh seconded the resolution. He said the reasons which led to the selection of Blackpool instead of Manchester in 1921 no longer existed, and a thoroughly successful conference could be held in the city next year.

Mr. Simkiss added that Manchester was the best centre in the North of England for such a conference.

The resolution was passed unanimously.

Trade Talk.

The Blaenavon Company, Limited, have damped down one of their furnaces.

The Gorwall Company have removed to Faraday House, 8-10, Charing Cross Road, London, W.C.2.

The Teams Engine & Boiler Repairing Works, Teams, Gateshead-on-Tyne, have been seriously damaged by fire.

A japanning shop at the Diamond Foundry, Luton, of the Davis Gas Stove Company, Limited, was recently destroyed by fire.

At a meeting of the Metallurgical Club, in the Royal Technical College, Glasgow, Mr. P. M'Nair read a paper on "Stainless Iron."

Slight damage was done by a fire which recently broke out in a store at the works of F. W. Sibley & Company, Goldcroft, Yeovil.

In consequence of a mishap to a fly-wheel at the Lydney works of Richard Thomas & Company, Limited, extensive damage was done.

The Still Engine Company, Limited, announces that the remaining £50,000 debentures and 50,000 "A" shares are now offered to shareholders at par.

Hunter & Company, consulting and general engineers, have removed from District Bank Chambers, Harrogate, to Trafalgar House, Waterloo Place, London, S.W.1.

Bevan & Company (Iron and Brass Founders), Limited, Canal Side Wharf, Neath, have disposed of their business to Mr. W. E. Cope, of Glentworth, Sketty, Swansea.

The wages regulated by the Sliding Scale under the Midland Iron and Steel Wages Board will be reduced 5 per cent. from Monday, October 9, to Saturday, December 2.

Lithgows, Limited, of Port Glasgow, have secured contracts for the construction of four cargo steamers, making a total of eight orders for new vessels placed in the district within the last two weeks.

Mr. J. W. Hall, iron merchant, Lufton Street, Ashford, Kent, has sold his business, which will in future be carried on by his son, Mr. G. M. Hall, and Mr. H. R. Thorne as J. W. Hall & Company.

Wage increases running from 10 to 15 per cent., and affecting all classes of workers at the Sydney (N.S.) steel plant of the British Empire Steel Corporation, have recently been announced. Approximately 2,800 men are affected.

The Elgar Scholarship in Naval Architecture (1922) has been awarded by the Council of the Institution of Naval Architects to Mr. William Sprague, of H.M. Dockyard, Devonport, and the Earl of Durham prize to Mr. F. F. Crocombe, of H.M. Dockyard, Portsmouth.

At the next meeting of the Diesel Engine Users' Association, which will be held on Friday, October 27, at the Institution of Electrical Engineers, a paper on "The Care and Maintenance of Diesel Engines" will be discussed. The subject will be introduced by Mr. G. E. Windeler.

The Gas Department of the Borough of Port Talbot are inviting tenders for the supply and delivery of 2,500 yds. of 4-in., 2,500 yds. of 3-in., and 2,600 yds. of 6-in. cast-iron gas mains. They are to be to British standard specification and coated with Dr. Angus Smith's solution. Tenders must be in the hands of Mr. Moses Thomas, Town Clerk, Port Talbot, by October 16.

Company News.

Globe Tank & Foundry (Wolverhampton), Limited.—Capital £2,500.

J. B. White (Ratcliffe), Limited, Medland Street, Ratcliff, E.—Capital, £10,000 in £1 shares. Brassfounders.

J. & W. Wood, Limited, 62, Birmingham Street, Stourbridge, Worcs.—Capital £6,000 in £1 shares. Ironfounders.

Huntley Oil Engines, Limited, 4A, St. Andrew Street, Edinburgh.—Capital £5,000 in £1 shares. Directors: T. Huntley, J. M. Thomson, W. Hall, and J. Allan.

Clyde Crane & Engineering Company, Limited, 11, Merry Street, Motherwell.—Capital £30,000 in £1 shares. Directors: J. Jardine, D. Wilson, and J. Macgregor.

Bloomfield Engineering Company, Limited, 11, Avenue Road, Bloomfield Avenue, South Circular Road, Dublin.—Capital £1,000 in £1 shares. Directors: E. Hubbard, W. Byrne, and G. Byrne.

Coltness Iron Company, Limited.—Net profits £14,733; brought forward, £19,703; transferred from reserve to pay dividends on first and preference shares, £40,000; redemption fund, £25,000; carry forward, £21,738; ordinary dividend passed.

Bengal Iron Company, Limited.—Net profit, £125,492; brought forward, £22,178; written off in respect of exchange revaluation, £72,620; depreciation and colliery sinking fund, £25,833; debenture interest accrued, £1,104; preference share dividends, £37,500; net balance, £61,054; ordinary dividend, 2½ per cent., £39,350; carry forward, £21,703.

Burton Foundry Company, Limited.—Capital £50,000 in £1 shares (25,000 5 per cent. cumulative preference), to acquire the business carried on at Burton-on-Trent, Staffs., as "The Burton Foundry Company," and to adopt an agreement with F. S. Muirhead, P. D. Muirhead and A. Aitken. Directors: F. S. Muirhead (chairman), P. D. Muirhead, and A. Aitken.

United Steel Companies, Limited.—Liquidation of Workington Iron and Steel Branch and Harrington Coke Ovens completed, and assets appear in balance-sheet for first time; figure for "land, minerals, etc.," increased by £1,849,460 to £4,174,145, and goodwill increased by £563,456 to £816,825; losses for year of branches already liquidated, £156,675; loss by associated companies, £348,856; total loss, £505,531; stocks written down by £298,667; maintenance of idle plant, £312,321; surplus, apart from these items, £105,457; accumulated profits from branches liquidated embodied in profit and loss account with result that after charging branch losses for year and other charges and reserves there is net surplus £440,743.

Deaths.

Mr. J. P. Wirreck, manager to the Dudbridge Iron Works, Limited, Stroud, died on September 20, aged 41 years.

Mr. W. Pochin, chairman of the Standard Engineering Company, Limited, Leicester, died recently in his 81st year.

Mr. J. Keeling, for many years works manager to C. Akrill & Company, ironfounders, West Bromwich, died recently.

Mr. A. Lund, secretary of Riley Bros. (Boilermakers), Limited, Stockton-on-Tees, died on September 20, in his 54th year.

Mr. J. Whitehouse, one of the founders of the firm of J. & J. Whitehouse, Phœnix Foundry, Tipton, died on September 19, in his 88th year.

Mr. R. Hartley, formerly senior partner of R. Hartley & Sons, metal merchants, Long Brackland, Bury St. Edmunds, died on September 26, aged 74.

Mr. D. C. Watson, who was formerly connected with the South Durham Steel & Iron Company, Limited, and was on the Council of the North of England Iron & Steel Merchants' Association, died on September 20, in his 53rd year.

Monsieur Herman-Victor Hubert, honorary Inspector-General of Mines in Belgium, died on September 30, at the age of 73. The deceased gentleman was a member of the Iron and Steel Institute and the Institution of Mechanical Engineers.

MALLEABLE IRON PIPES.—Readers interested in the standard sizes for malleable iron pipe fittings can have the latest information by applying to the Secretary of the British Standards Association (Mr. C. le Maistre) at 28, Victoria Street, London, S.W., for Reports Nos. 143 and 154.

Book Review.

The Electro-Metallurgy of Steel. By C. C. Gow, A.R.S.M., B.Sc. Published by Messrs. Constable & Company, Limited, 10-12, Orange Street, London, W.C. Price 27s. 6d. net.

A study of the books devoted to the application of electricity to steel melting before the advent of Mr. Gow's book cannot fail to impress metallurgists who are *au fait* with the subject that it was high time a treatise was published which was something more than a write-up around manufacturers' catalogues. The book under review, though still not perfect, is by far the best contribution to the subject ever written in the English language. The writer is obviously one of great practical experience, whose knowledge has been gained by working all hours of the day and night. It presents in many places that clarity of thought and carefulness of observation which is so necessary in a metallurgist. Though his practical experience has mainly been derived from the Héroult type of furnace, he treats of conducting-hearth furnaces in as fair a manner as can be expected. Where he finds phenomena difficult of explanation he admits the fact and leaves theorisation to the reader. For instance, on pages 128 and 129 he says: "It is difficult to explain the discrepancy [the increase of phosphorus some six to eight points from slagging to casting], since the increase cannot possibly be due to a reduction of phosphorus from the unappreciable quantity of oxidising slag left behind after a careful skimming." We have in our possession a series of analyses of oxidising slags made in one of the most reliable laboratories in Europe, which show that such slags may contain over 30 per cent. of metallic iron and over 0.5 per cent. of phosphorus. Now, using these figures, this means that 92 lbs. of the oxidising slag would have to be left on the bath and banks of a three-ton furnace. Now such a furnace would, according to the author, require about 3 cwts. of lime, and produce probably 10 cwts. of slag. Therefore it would require that 8.3 per cent. of the slag be left on the bath and banks. We would further point out that these slags are amongst the heaviest known to ferrous metallurgy, and are often sold for the iron content. This being so, it is possible to visualise that they might be at slagging temperatures partially miscible in the bath. Then no amount of slagging can be of avail.

There are several other small points on which we are not in agreement with the author, but their recital might not carry the subject farther. We would, however, point out that his figures for calcium carbide in reducing slags are open to criticism, as the content of this compound is constantly diminishing owing to the action of atmospheric moisture. This is partially confirmed by the author's figures, wherein the lime content varies inversely with the calcium-carbide content.

There is one more point which should be cleared up in future editions, that is, the important question of sampling of high-speed steel. The method adopted in some works is to take the white-hot sample into a definitely dark room, and when no longer visible to the eye to quench in whale oil and then quickly burn off the oil in an ordinary laboratory muffle. It will then be found that it is possible to drill the sample comparatively easily.

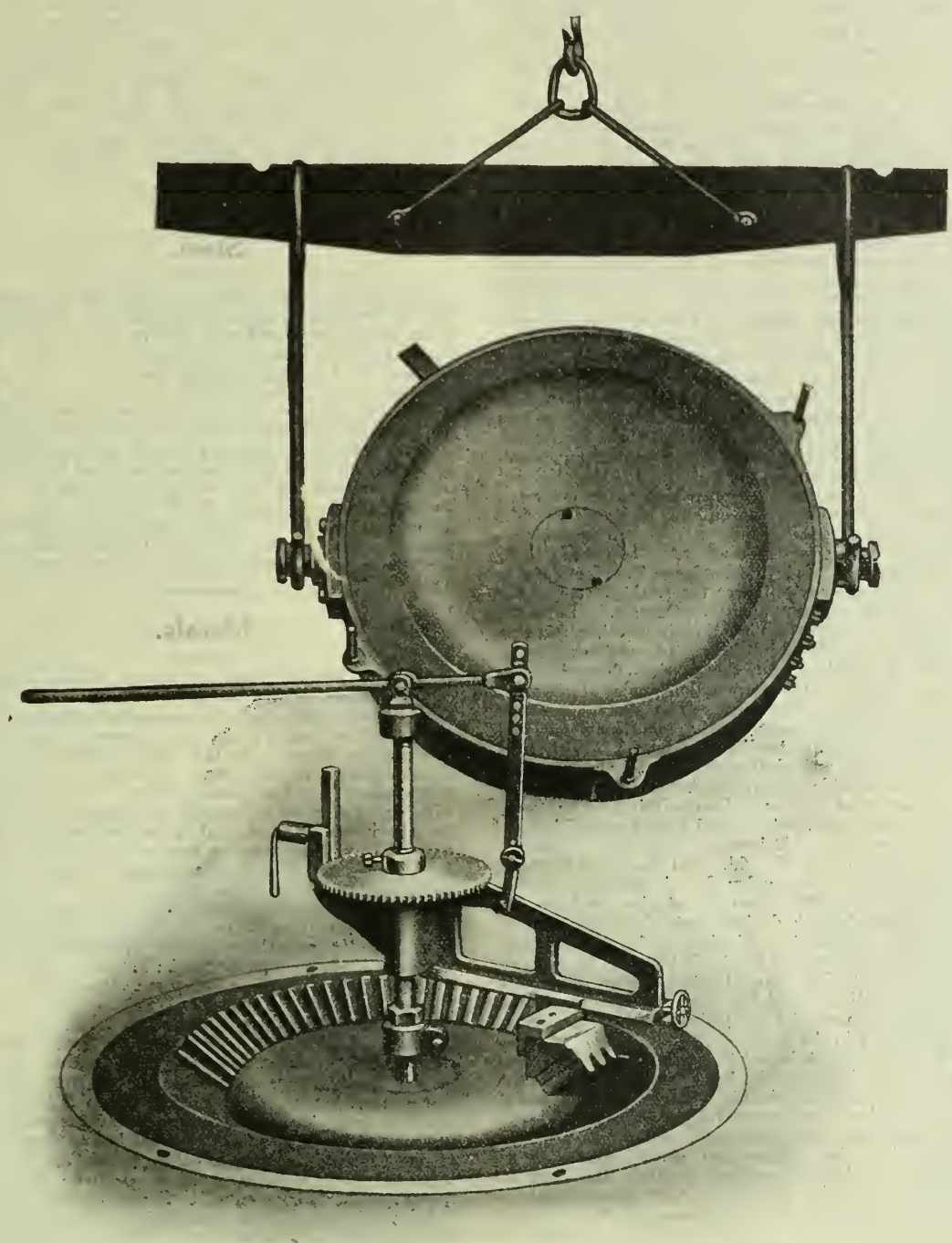
The book is divided into 15 chapters and illustrated with 132 figures. It should be in the hands of everybody connected with the electric-furnace industry, as it outlines the industry from the point of view of one intimately connected with it, and herein lies its true value.

British Brazing Company, Limited.—It has been resolved:—That the company be wound up. Mr. W. R. Graves, 17, Coleman Street, E.C., has been appointed liquidator.

British Electric Vehicles, Limited.—A petition was presented, September 25, by International Trade Exhibitions, Limited, Broad Street House, New Broad Street, E.C., promoters of exhibitions, for the winding up of the above company. Hearing, Royal Courts of Justice, Strand, October 17. Messrs. A. Benjamin and Cohen, 23, College Hill, E.C., solicitors.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

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BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

A somewhat more cheerful note is observable in reports from the chief centres of the pig-iron industry, and although production is still on limited lines, furnace outputs at present are fully absorbed, and two or three additional plants are being restarted or already in blast. The recent heavy demand on export account, however, is now on a diminishing scale, and new business in that direction can hardly be further anticipated, while home consumption continues still much below a normal average. In the Midlands producers are still experiencing a slack time, consumers buying very sparingly, with only a sluggish demand, more especially for foundry qualities. Inquiries for forge iron also are disappointing, although in somewhat improved volume as compared with recent reports. General all-round depression in the Scottish iron and steel industries has, of course, had a corresponding effect upon markets for raw material, and with the steadily diminishing demand on United States account Clydeside makers are again dependent upon hand-to-mouth buying, which is barely sufficient to keep furnaces already in operation in full employment. There is now very little forward buying transacted on the Glasgow Exchange, and there were only sellers represented at last week's meeting of the iron ring, when offerings failed to elicit a response, and no dealings were consequently reported. In the Falkirk district some Continental competition is in evidence, imported No. 3 quality being on offer at about 92s. 6d., delivered. On Tees-side business is still more concerned with American requirements than home consumptive demand, and this business it is confidently expected may extend well over the final quarter of the current year. Consequently, Messrs. Bolckow, Vaughan & Company are putting in another furnace, and will be on Cleveland iron, but whether any of this will be available for the market depends upon the requirements of Messrs. Bolckow's steelworks, which are reopening this week. The general question of increase of output is largely conditional on fuel costs, which continue steadily to advance. With coke relatively scarce and dearer than ever the prospect of any considerable expansion in production in the near future must continue disappointing. The home trade is rather more active, and larger quantities are going to Scotland. Prices are firmly held, No. 1 and silicious quoting 97s. 6d., and No. 3 G.M.B. at 92s. 6d. For No. 4 foundry 90s. is named, and for No. 4 forge 85s. The shipments of pig-iron from the Port of Middlesbrough during September amounted to no less than 65,361 tons, including 4,928 tons from Skinningrove, as compared with 37,972 tons in August, an increase of 27,389 tons. Of the foreign shipments proper, amounting to 51,996 tons, nearly two-thirds, or 31,119 tons, went to the United States, as against only 9,862 tons in August.

In the East Coast hematite market a fairly active business is passing, and the lower quotations of recent dates are no longer obtainable. Stocks are well down, and some makers are pretty fully sold over the next few weeks. But conditions vary, and prices are still somewhat irregular. There are cheap sellers at as low as 89s., while others are quoting 91s., but in general the quotation for East Coast mixed numbers is about 90s. per ton. The premiums for No. 1 varies from 6d. to 1s.

Finished Iron.

Very little sign of improvement can be noted in the general outlook of the finished iron sections of the trade, buying, as previously reported, being confined to strictly immediate requirements, and orders, as a rule, on quite an unimportant scale. The quarterly meeting at Birmingham this week is hardly anticipated to disclose any change for the better in the conditions now prevailing, and as far as prices are concerned, makers are practically unanimous in asserting that nntil the costs of production and transport are materially reduced lower quotations are entirely cut of the question. Foreign competition in such material as nut and bolt iron continues active, and to secure orders Black Country makers have to make concessions in prices which they can ill afford in existing circumstances. Crown bars are also unfavourably situated at the moment, makers now accepting slightly shaded quotations to obtain business. Makers of marked bars, though more steadily employed, have few future commitments booked, and would welcome some substantial orders to ensure mills working continuously over the remainder of the year. The output returns of the Midland Iron and Steel Wages Board for July and August are slightly more encouraging as compared with those of the two preceding months.

Scrap.

Conditions in the scrap metal trade can hardly be described as satisfactory, and with one or two exceptions the business passing in the various markets continues quiet, if not actually depressed. Accepting Middlesbrough as a representative market for iron and steel scrap, an outstanding feature has been the continued demand for heavy qualities of the latter material which for a satisfactory specification is freely realising 65s. per ton. Heavy steel turnings and cast-iron borings are also still in demand, and the price is firm at about 52s. 6d. per ton. Business in cast iron is quiet, good machinery qualities in handy pieces making round about 73s. 6d. per ton, with ordinary descriptions 70s.

Steel.

Movements in the steel industry continue without special features of fresh interest and are for the time being mostly concerned with semi-products, the demand for acid billets being rather better, with slightly more freedom in buying of basic qualities. There has, however, been some reaction in the crucible steel branch, the September returns showing unfavourably as compared with the more hopeful prospect in August. Various reasons are assigned for the set-back, the chief being the unsettled conditions of the Near East causing buyers to hold off the market, and also the quick passage of the Fordney Tariff Bill into law. The high-grade steels in which Sheffield specialise are making a little better showing, but the bulk of the orders coming to hand is for the cheaper qualities.

Metals.

Copper.—The tendency of values in the standard copper market during the past week has been fairly steady, notwithstanding the depressing influence of the political situation, a slight improvement in the home consumptive demand having had a stimulating effect upon buying. Reports from America state that the unsettlement in European political affairs combined with the weakness of sterling exchange caused some dulness in the market, but although quotations gave way slightly there was no pressure to sell. German buying in the U.S.A. has lately been on an improved scale, that country being still the best Continental customer of American copper, although her takings are much less than they were in the earlier part of this year. Current quotations:—*Cash:* Wednesday, £63 5s.; Thursday, £63; Friday, £62 10s.; Monday, £63 2s. 6d.; Tuesday, £63. *Three months*: Wednesday, £63 17s. 6d.; Thursday, £63 10s.; Friday, £63 2s. 6d.; Monday, £63 12s. 6d.; Tuesday, £63 12s. 6d.

Tin.—Messrs. Henry Bath and Son, Limited. report:—This market, with slight fluctuations, has improved steadily. Consistent buying by large interests has caused bears to cover freely, and although the demand from English consumers leaves room for improvement, America has at times been a free buyer. It is generally considered that prices are destined soon to reach a higher level as the consumption of tin is now just about equal to the production, and the potential consumption is considerably in excess of the potential production, so that if trade were allowed to go ahead without any outside interference from labour troubles and political disputes, only a higher price could keep the balance more or less level. The tin-plate works in America are doing a big business, and although the works in South Wales complain, they have nevertheless secured some very good orders lately. The East has continued to sell moderate quantities at full prices. Current quotations:—*Cash*: Wednesday, £163 5s.; Thursday, £163 10s.; Friday, £163 10s.; Monday, £163 17s. 6d.; Tuesday, £165 2s. 6d. *Three months:* Wednesday, £164 7s. 6d.; Thursday, £164 10s.; Friday, £164 12s. 6d.; Monday, £165 2s. 6d.; Tuesday, £166 5s.

Spelter.—The market for this metal records a consistent advance in values, the principal strength having been in the forward position. Buying on home account has shown some improvement, while the absorption of the metal in America is steadily growing. Current quotations:—*Ordinary*: Wednesday, £33; Thursday, £33; Friday, £33; Monday, £33 2s. 6d.; Tuesday, £33.

Lead.—Business in soft foreign pig has again been on an active scale, and the heavy arrivals have been readily absorbed. America is consuming large quantities, while the Continent is also buying more freely. Current quotations:—*Soft foreign (prompt)*: Wednesday, £25 7s. 6d.; Thursday, £25 7s. 6d.; Friday, £25 2s. 6d.; Monday, £25 5s.; Tuesday, £25 5s.

THE

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Contents.

	PAGE
Presidential Addresses	311
European v. American Moulding Machine Practice	312
Semi-Steel	314
Foreign Trade in September	314
Heating Metal Patterns Electrically	315
Correspondence	316
Iron and Steel Production	316
An Apprenticeship Course in Foundry Practice—XIV.	317
The John Surtees Memorial	320
Foundry Cupolas	321
The German Iron and Steel Industry	323
Institution of British Foundrymen	324
What's Wrong with the Foundryman?	328
Iron Ore Crisis in France	328
New England Foundrymen's Association	328
Electric Furnace Operation	329
The Selling Price of Grey Iron Castings	330
Contracts Open	330
The Nitrogenisation of Iron and Steel by Sodium Nitrate	331
Research for Metals Industry	331
Trade Talk	332
Catalogues Received	332
Company News	333
Gazette	333
Personal	333
Deaths	333
More Foundry Papers	333
Iron and Steel Markets	334

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Presidential Addresses.

Whilst the education of the foundry youth has been touched upon in most of the presidential addresses delivered to the various branches of the Institution of British Foundrymen at the opening of the session, other important phases have also been dealt with. Mr. Roberts, before the Coventry Branch, made out a strong case for the co-operation of the patternmaker and the foundryman by showing him frequent defects in his work. Mr. Lambert, before the London Branch, by means of practical demonstrations with metallurgical testing apparatus, essayed to dispel the bogey of science for foundrymen.

A new note, savouring of desperation, was struck by one Branch president when dealing with the technical training of foundry youths. He advocated a compulsory system, and even invoked State aid. We have little faith in such a proposition, as anything which is procured at no personal cost and a minimum of effort is valued at its cost price and its energy expended. This is the type of education which Mr. Riddel designates as "spoon fed," and characterises as "reinforcing ignorance." Now the scheme suggested by Mr. H. J. Young in his address before the Newcastle Branch, which involved the examination by the Institution of British Foundrymen and the awarding of certificates on the lines adopted by the Institute of Marine Engineers, presents much of interest. But why not state the inevitable, *id est*, that the future will insist on some form of examination or outside examining body equivalent for membership for the Institution of British Foundrymen such as obtains in other chartered institutions?

Another point emphasised is the publication of a foundry reference handbook. We admit that there is a distinct need for such a book, as there is nothing British on the market which quite supplies the need. We are carefully considering the matter, and, in fact, are already working on the subject. It will obviously take some little time, as many of the essential features are still in a provisional and in some cases chaotic condition. Test-bars are an example of the former and grading by analysis the latter. On its completion an edition will be published annually, and be distributed free to subscribers of THE FOUNDRY TRADE JOURNAL.

Mr. Liardet's apprenticeship scheme has been commended by foundrymen as one of the most comprehensive ever put forward. It has been adopted by the foundry owners of the West Riding of Yorkshire, who are co-operating with the Bradford Technical College. It was very disappointing to hear at last Saturday's meeting of the local branch of the Institution of British Foundrymen that the response was poor. Professor Charnock has arranged a splendid course, and he must not be pessimistic. For years the evening classes held in the metallurgical department of Sheffield University were over-crowded, and we feel sure that once classes are firmly established in the district the boys withholding will be considered "outsiders." They will realise that they are missing not only a chance of better education, but also better jobs. Perhaps the success of the Sheffield metallurgical classes was that once having satisfied the professor as to their knowledge of chemistry either by a short *viva-voce* or by passing a preliminary examination in a course of chemistry for metallurgical students, they could start directly with the courses which bore directly upon their daily occupation. A fair percentage of the lads who took advantage of the opportunities afforded were laboratory boys, many of whom have made good to such an extent that their names are household words in the metallurgical world.

We were pleased to notice that Mr. Haigh, in his address before the Lancashire Branch, confirmed what has already been said previously in this column, that the higher administrative positions in the foundry of the future will be held by highly-trained practical men rather than the purely scientifically-trained man. In other words, the practical man who has acquired a thorough knowledge of the technology of his trade. We consider that Mr. Haigh's most important statement was that when conditions return to normal there will not be any surplus of skilled moulders. This lends an added importance to the recruiting of suitable youths for foundry work. We firmly believe that the foundry possesses excellent prospects for boys who care to rough it in the day time and spend their evenings improving their minds.

European *v.* American Moulding Machine Practice.*

By E. Ronceray,
President, Societe Anonyme des Etablissements Ph. Bonvillian and E. Ronceray, Paris, Choisey-le-Roi.

At the 1921 meeting of the American Foundrymen's Association, Mr. H. Cole Estep, European representative of "The Foundry," gave a short description of moulding-machine construction in Europe. The object of this Paper is to give an opinion from a European on the same subject, but adding thereto a description of innovations made from that time. American foundrymen will thereby learn the European point of view. We take advantage of this occasion to correct some discrepancies and to complete Mr. Cole Estep's description on points which necessitated them.

The Scope of Compressed Air.

One point which strikes an American observer who visits European foundries is the small use made of compressed air as a motive power, and on the other hand the considerable extensions of hydraulic pressure, a factor practically unknown in American foundries. The reasons for this are simple and of prime importance. Compressed air at a pressure of from 60 to 100 lbs. does not allow of the obtaining of high pressures on the moulds, and from this fact one can only use it for the making of small moulds. For such work it is both rapid and practical,† but it is not good from the point of view of pattern drawing. In short, it is incapable of giving steady and controllable movements. Thus allowance is made by means of some intermediate element to obtain a withdrawal of the pattern on precision lines by such means as an oil brake (Tabor)‡ or a specially designed hand starter (Mumford), or by similar means.

Leakages.

The leakages of compressed air into the atmosphere are not troublesome, but for this reason they are neglected, with the result that the power lost through them is often equal or more important than the power actually utilised. A. Wardle says§: "It is important to stop the smallest leakage in the pipe system. A ¼-in. diameter round hole would allow air to 100 lbs. pressure to escape at the rate of 100 cub. ft. per min., and 20 h.p. would be required to enable the compressor to cope with this leakage." However, by its nature, compressed air is not economical, as the average motive power absorbed by each compressed air machine is from 1 to several h.p., and the section of the pipes is from one to several inches.

Water pressure, on the other hand, utilises pressures varying from 750 to 1,500 lbs. per square inch. At these pressures, from eighty to twenty times greater than those of air, the piston sections remain rather small, even for the higher pressures, consequently even for large moulds, sizes of machines and prices can be kept within reasonable limitations. Water at high pressure, at the same time, makes for a low consumption and a high speed of water in the pipes, which can thus be made of very small section.

In a carefully-designed machine the water consumption is very low, and the motive power absorbed is ridiculously small. Thus it is quite usual practice to work twenty moulding machines at full output with a 5-h.p. pump, the mains being copper piping ⅞ in. inside dia. and 3-32-in. thick walls. The water lends itself to rapid movements for ramming, to initial slow, and then to the more rapid and steady movements for the pattern drawing. It is quite unnecessary that there should be any complication, and the most diverse movements can be obtained by small dimensioned parts. Any water leakages are troublesome, and they obviously require immediate attention, which tends to eliminate both water and motive power losses. They are easy to avoid, however, by the use of well-made piping and leather or india-rubber joints for the fixed parts, and high-class packings for the movable parts.

Freezing.

The most important inconvenience is freezing in cold weather, but it must be considered with no more importance than it deserves. First of all, a water return pipe and a non-freezing mixture can be used, but all the types of water piping in towns, works, flats, water taps in foundries, hydraulic machinery in sea ports and railway depôts, steel works, etc., show that this inconvenience is a mere talking point. As a matter of fact, the temperature ought never to reach freezing point in foundries, because obviously the sand would freeze, and all work would automatically stop. On the other hand, some new machines are so laid out that all the hydraulic section, including the piping, is underground, which practically precludes any chance of freezing. Compressed air, too, is not completely free from frost troubles, for in the air pipe important condensations take place, and the cooling due to air expansion may transform it into ice.

Hydraulic versus Pneumatic Pressure.

There is little doubt that water pressure shows a definite superiority over compressed air for machine moulding, particularly in countries where coal economy is acute or where motive power is dear. The numerous installations of compressed air in American foundries before the advent of moulding machines, the low price of coal in that country, and the complete absence of a spirit of economy, have alone been the determining causes of the choice of air, though the opinion expressed by Mr. W. Lewis, President of the Tabor Manufacturing Company, is (*) "that water cannot compete with air as a working fluid for foundry use."

The choice of compressed air in England must therefore be considered as an error of judgment when engineers of that country aim at constructing such machines. From this fact it is not difficult to concede that the two countries having the same language and so easy and constant communication by means of the exchange of literature and men to a much larger extent than with the European Continent, often follow the American ideas even though they are not the best.

Amongst British machines, the greater part imitate the American jarring machine. Only a few work by pressure, and are original—that is to say—they are not, more or less, distant copies of American machines. Additionally, they are not described by Mr. H. Cole Estep, because, without doubt, they are, in our days, considered out of date. Amongst those who ram by jarring, some employ a guiding by multiple rams, of which the making appears to be very difficult. We prefer, however, single-ram machines wherein the ram is at the same time the guide.

Thus in England, apart from some old-fashioned, but at the same time well-designed, hand-machines, and some original and little used compressed-air pressure machines, manufacturers have imitated the American jarring machine, and that to a small extent which scarcely justifies the opinion of Mr. Cole Estep, which gave the palm to Great Britain for the construction of moulding machines in Europe.

Throughout the technical Press, and in a few recent books, there will be found constantly stated a false aphorism, that jarring machines "are ideal as far as ramming is concerned."

---

* From a Paper as submitted to the American Foundrymen's Association, but slightly abridged.

† "Machine Moulding," by Wilfred Lewis, President of the Tabor Manufacturing Company, page 28: "It (the Jar Ramming Machine) will not ram small work as quickly as a squeezer or split pattern Machine, and such a jarring Machine for half moulds weighing less than 1,000 lbs. is not often recommended."

‡ "Machine Moulding," by Lewis, page 21: "The Machine draws the pattern by means of a cylinder and plunger, using compressed air on hydraulic oil or water to effect the movements." Page 33: "The power used is compressed air, and this acts upon liquid within the pattern-drawing plungers."

§ Paper delivered before the Birmingham Branch of the I.B.F. Foundry Trade Journal, June 2, 1921, p. 499.

* Lecture delivered at the Franklin Institute, May 18, 1911. Mr. Lewis says: "The French machine swinging type of Bonvillian and Ronceray, has a number of attractive features, and is said to be very successful in France, where hydraulic power is more popular than it is here, but the machine has not been so successful on this side of the Atlantic, for the simple reason, no doubt, that water cannot compete with air as a working fluid for foundry use."

To such an aphorism we cannot possibly subscribe and associate ourselves with many American foundrymen with whom we have chatted, especially Mr. W. Lewis, that when pressure ramming is possible, it gives, in the large majority of cases, results superior to the jarring machines. We admit, however, that in a few limited cases the jarring machine can show advantage. It is an established fact and one which is easy of proof that an ordinary mould is better and more quickly rammed by pressure than by jarring.** The fact that the number of pressure machines used in America for small and medium size moulds are in outstanding majority is sufficient proof.

It would be interesting to learn, therefore, why jarring machines are in favour for large moulds in America. Basically, it is solely due to the impossibility to ram large moulds adequately by pressure, on account of the low pressure of the fluid usually employed.

The skill of American engineers has turned to use the dynamic effort produced by the impact of a mass raised by compressed air and falling down on an anvil, in place of the static effort derived from simple air pressure.

The claimed advantages of jar ramming, which are not valueless, but secondary, did not count for anything at the beginning, but they have been appreciated since, and it can safely be asserted that they are as little known as are the troubles associated with the system. The only reason why they have been made at the beginning is that it was impractical to make machines to squeeze large moulds by compressed air.

Mr. E. S. Carman stated* that "Jolt ramming accomplishes the ramming of the mould in a more satisfactory manner than a squeezer machine." With such a statement we cannot possibly agree, for Carman describes at some length the complete process of ramming by jarring, which comprises:—(1) Clamping the box. (2) Jolt ramming. (3) Spreading the sand. (4) Butting off. (5) Striking off.

According to this authority,† jolt ramming is accomplished in 5 to 30 seconds. This time is equal or more to squeezer ramming on any type of machine, but the other four operations are not there necessary. Thus it is not under the heading of speed that the "more satisfactory manner" claimed for jolt-ramming machines can show superiority. What about the quality of work? According to Carman‡ the requisites of ideally-rammed moulds are:—(*a*) Uniformly rammed sand. (*b*) Correct density in various parts of the mould. (*c*) Uniformity of various moulds made from the same pattern.

The sentences which follow explaining that the ramming is the same "over the entire pattern" and that the mould is "of uniform density throughout," are not only manifestly erroneous‡‡ but also contradictory with the curve of ramming shown on page 160 of the same book, in spite of these curves being distinctly wrong.

P. Lohse (Stahl und Eisen) has religiously copied or imitated this curve, because doubtlessly it was in print. It is by such means as this that unsubstantiated platitudes get implanted in students' minds, as unfortunately everybody writes or copies without trying things out for themselves.

We hope to prove by systematic experiments that a basic error exists in the "squeezing" curve. As to that of jolting, it is not 50 per cent. of the pressure at the joint which is applied to the back of the flask, but less than a tenth of one per cent. "sand is so loose that it requires additional ramming."§.

We are far from that ideal ramming claimed very thoughtlessly. But this is not the end. It is interesting to ask what is ideal ramming. It would be probably difficult to come to a unanimous agreement upon this point, for the foundry still remains in a state so empirical that every individual is possessed of an opinion on this subject, more or less reasoned. It is perhaps possible to accept a statement that it would be rational that the hardness of the mould is proportional to the pressure of the metal, that is, rammed softer from the bottom to the top of the mould, so that under such conditions the gas will escape through the sand in a regular manner under the variable pressure of the column of metal. Other people would undoubtedly prefer the part of the core surrounded by metal to be softer. Such opinions are sensible.

Taking as an example a split axle box, the portions of the mould which are rammed the hardest should be shown darker in the case of a mould rammed by a jarring machine. For the drag it is exactly the opposite of what is required, and if for the cope it is good for the joint, it is bad for the higher portion of the casting. Unfortunately, no means exist to do otherwise. On the other hand, pressure-ramming permits the operator to vary at will the pressure on the mould. It is a recognised fact that the shocks of jarring machines give much trouble in the foundry*, and the number of highly ingenious contrivances which are supposed to overcome them merely show the number of troubles they cause. As a direct corrollary, the bending of the flasks when working on flat moulds renders work extremely difficult, since the rebounding of the sand, which, like the shocks, has given rise to the adoption of numerous and highly ingenious arrangements, renders the moulding very difficult, especially for flat moulds. Finally, jolt ramming produces in sharp angles and under bosses soft spots, which were recently the subject of a highly interesting discussion at the Congress of Foundry Technical Associations at Liége.†

If, in spite of all these inconveniences, jarring machines have assumed so great a development in America, it is because they have not only inconveniences, but they show also some advantages. These advantages are especially evident in very deep moulds, the bending of the flasks being completely suppressed. Under these conditions the rebounding is less dangerous. The differences of hardness from the lower to the upper portions of the mould are not so marked, and the packing of a huge mass of sand under these conditions is satisfactorily accomplished. Ramming not necessitating the use of special ramming plates, and consequently no preparation whatsoever for the machine, is thus possible to use for a limited number of moulds principally for ramming purposes, the pattern drawing being accomplished either on the machine or otherwise. However, it is a simple process, easy to understand by men used to hand moulding who only see in the use of the machines a method of reducing their fatigue, all the remainder of the work being carried out similarly to hand moulding. Briefly expressed, if compressed air pressure allowed of the easy ramming of large moulds, it is highly probable that the jarring machine would not have assumed such a great development, and we do not hesitate to say that in a country like England where compressed air is not very extensively used in foundries, and where hydraulic is used as an everyday matter, it was a false step to have exploited the jarring machine rather than to have preserved it for special cases where it shows outstanding advantages. Jarring machines also allow of the ramming of deep and narrow spaces in patterns such as those for long-ribbed heating pipes, which, however, American moulding machine makers declare impossible of attainment up to now. The use of squeezer machines has not always been understood. It is extremely easy to ram deep boxes with squeezer machines by carry-

** Lewis, page 28.

* (1) E. S. Carman, "Foundry Moulding Machines and Pattern Equipment," Penton Library, pages 13 et. seq.

† (2) E. S. Carman, "Fonndry Moulding Machines and Pattern Eqnipment," Penton Library, page 32.

‡ (3) E. S. Carman, "Foundry Monlding Machines and Pattern Eqnipment," Penton Library, page 33.

‡‡ W. Lewis, page 28: "It is not, however, every pattern that can be rammed in this way, and care mnst always be taken to avoid projections on the pattern which interfere with the proper flow of sand. This sometimes necessitates the nee of a core not required for hand ramming . . . Althongh the jarring machine is not universal in its application, it covers a very broad field of the work. . . . The packing of sand by jarring is natnrally greater in a vertical direction than horizontally." Page 29: "To obtain the best resnlts a good deal of judgment and patience is frequently reqnired. . . ." The back and sides of the mould are not, of conrse, rammed as hard as the bottom.

§ E. S. Carman, page 15.

* W. Lewis, page 24: "It is not generally safe to set up finished moulds with hanging sand in the neighbourhood of a jarring machine of this type, and in some foundries the jarring machine has been just out of service for days or weeks pending the completion of large floor work. In fact, the damaging effect of large jarring machines is too well known to need confirmation, and to reduce this to a minimum the drop of the table has been decreased, while the foundation has been increased."

† See also W. Lewis, page 20.

ing out the operation in several stages. Usually two squeezings are sufficient, and as this work of pressing is quite rapid and that, once made, the work is not partly but entirely finished, it will readily be seen that there are found in many cases distinct advantages from the use of the squeezer machine, even for the deepest moulds, notably where pattern presents projections, bosses, loose pieces and the like. European practice, particularly French, differs considerably in this respect from American practice. Whilst in America the aim has been to simplify machine moulding by the use of as many cores as are exteriorly and interiorly necessary, in France the trend of affairs has been to keep the number of cores especially of a complicated nature to the strictest minimum. By this method of working, the cost price is reduced, because cores are expensive both in material and labour; and what is still more serious, they give rise to complicated core setting and ugly fins which have to be fettled by hand at a price which is sometimes three or four times greater than the total value of the mould. Much cleaner work and a much lower cost price is obtained, even though the production by the machine be less than if it had had to only make an envelope of a rough type of ore which in reality constituted the mould to set cores inside.

This work necessitates the greatest competence and skill in the manufacture of pattern plates which have to be left to the sole care of the moulders by the processes invented and developed by the Ph. Bonvillian & E. Ronceray Company.

The objections usually associated with squeezer machines are usually due to ignorance as to the best means of carrying out the operations. Without wishing to cast a slur upon foundrymen who go in for machine moulding, it is not an exaggeration to say that any competence which they might possess in hand moulding can scarcely help them if they are desirous of getting the best results from machine moulding. Carefully studied, this fact appears more natural than paradoxical. Little by little machine-moulding methods have been involved, and are distinctly moved from hand-moulding customs, so much so that the digression has become enormous, and perplexes the most open-minded persons.

Light on Hand Moulding.

On the other hand, however, progress which has been made with regard to machine moulding undoubtedly has thrown much light upon hand moulding. The following example will illustrate this point: Because of the incompetence of men operating machines, it is the custom not to admit that they patch the moulds.

The pattern plate must be perfect and the pattern drawing accurate enough to give a perfect mould requiring no patching. Such a perfection in working conditions allows of the use of a much dryer sand, the dampness essential for patching by hand being no longer necessary. Little by little the possibility of using dry sand has been recognised, and has allowed of the production of a dry sand which flows better under pressure, that is to say, which approaches, in this respect, silica sand, which, as everybody knows, runs like water when it is perfectly dry. The ramming is thus accomplished under much better conditions than with a damp sand, but this is not everything. The dry sand ramming better, consequently at a distance from the pattern, no longer necessitates the use of a presser head close to the moderately restricted or deep parts, but a simple finger touch before the press ramming. It does not scab, and it remains so permeable that it is practically useless to vent the moulds. These new and highly interesting conditions are brought about by the every-day machine-moulding conditions, and have been too precious not to be profited by when hand moulding.

In the author's demonstration foundry, which has been placed at the disposal of foundrymen, they are invited to take particular notice of the apprentices using practically the same sands for green-sand moulding as those used for machine moulding, and using little or no peg ramming, but merely the hand tucking and the butt rammer, using no venting, obviously excepting the cores. If sand breaks, it is damped only where broken, and even then to the least extent.

This example is only one of the aspects of the question. Many others present the same divergence between old time methods, and those resulting from a systematic study of mechanical moulding.

Thus the question resolves itself into the following:

(A) For all moulds, small or medium, in boxes or boxless relatively shallow, squeezing is to be selected.

(B) For all moulds, small or large, low or deep, where the pattern drawing is most important, and those where projections and numerous loose pieces are use, the pressure ramming is to be selected even when it involves ramming by two or more squeezings.

(C) For large flat moulds jar-ramming presents great difficulties. Jarring machines are, however, to be recommended where there is a special difficulty of ramming for which it is specially convenient (large number of narrow pockets of sand) in spite of the difficulties mentioned above.

(D) For large moulds, of deep and simple castings, in which the pattern drawing does not necessitate any great degree of precision, or when there are few moulds to make, the jar-ramming is to be recommended. The finishing is then mostly made by hand.

(E) Water pressure is desirable in all cases for pressure machines, it alone permits of pressure-ramming large moulds.

This means that where hydraulic pressure is used, the pressure machine exhibits distinct superiority. The combination of the two methods of ramming can give good results, and it is at all times desirable that the pressure remains the chief feature, which is rarely the case in existing machines.

Semi-Steel.*

Semi-steel (*fonte acierée*) was used to a considerable extent by the Allies for projectiles, and the author suggests that there is a considerable commercial field for its employment. He describes its physical properties, and states that its resistance to repeated impact is about six times that of cast iron, while the ultimate tensile stress is about double. The chemical characteristics are given as:—S less than 0.12 per cent.; P less than 0.2 per cent; total carbon content less than 3.2 per cent. (of which approximately three-quarters is in the graphitic state); Mn 0.7-0.9 per cent.; and Si 1-1.8 per cent. The various methods of associating the iron and the steel, and the regulation of the proportion of graphitic carbon by adjusting the silicon content, are described. Numerous experimental results are tabulated and plotted, and the author comments upon these and explains the influence of the chemical composition upon the physical properties. Precautions to be taken during production are touched upon, and it is suggested that a shear test and a Brinell hardness test would afford sufficient evidence on which to accept or reject the material.—Prache ("Rev. Mét.").

Foreign Trade in September.

According to the Board of Trade Returns, the following figures show in tons the imports and exports of pig-iron, etc., for the United Kingdom during the month of September; tonnages for the nine months ended therein being shown in brackets:—

Imports: Pig-iron: Forge and foundry, 5,904 (37,650); acid, —— (155); basic, 5,761 (68,614). Castings, 318 (4,770); cast-iron pipes, 1,902 (14,184).

Exports: Pig-iron: Forge and foundry, 47,471 (180,363); acid, 22,279 (163,239); basic, 200 (3,242). Castings, 173 (1,048); cast-iron pipes, 5,815 (48,097).

At a meeting of the Birmingham section of the Institute of Metals, on October 10, Dr. F. Johnson gave a lecture on "Iron in Copper and Copper Alloys."

* Inst. C. E. Foreign Abstracts.

Heating Metal Patterns Electrically.*

By C. A. Cremer, Westinghouse Electric and Manufacturing Company, Pittsburgh.

When moist moulding sand is rammed up around a cold metal pattern a thin film of moisture collects on the surface of the pattern so that when it is withdrawn from the mould there is a tendency for some of the sand to adhere to it. This causes a roughening of the surface of the mould so that it will not yield a clean smooth casting. For many classes of work it is essential that the castings be clean and smooth, and therefore means must be used to overcome this tendency of the sand to stick to the pattern.

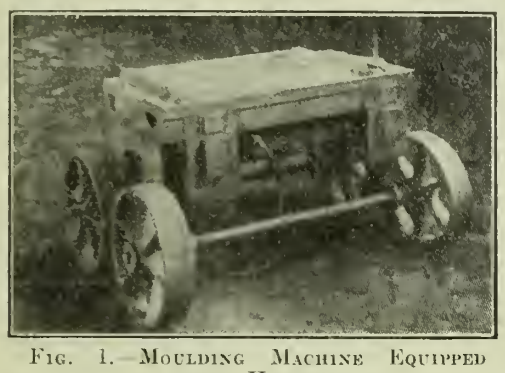


Fig. 1. Moulding Machine Equipped with Heater.

There are two ways of preventing this trouble; one is to dust a parting compound over the pattern and the other is to heat the pattern.

Compounds.

If a parting compound is used it must be applied frequently, at least for every second or third mould. This takes a certain amount of time, and furthermore it may be done carelessly, with the result that parts of the mould may not be covered, in which case imperfect moulds would result. This imperfect covering of the mould would be especially likely to happen in the case of intricate patterns or patterns with surfaces nearly perpendicular to the plane of the mould, to which surfaces the compound might not readily adhere.

Proper heating of the pattern, however, insures that all parts are equally prepared to prevent the sticking of particles of sand, and eliminates the time required for applying the compound.

The most common methods of heating metal patterns are by means of a gas flame or a paraffin torch. The gas flame is more readily applicable to stationary moulding machines, but cannot be conveniently used for portable moulding machines which are moved along the foundry floor as the making of moulds progresses. In such cases the paraffin torch, or a tin can filled with sand on which kerosene has been poured, is more frequently used.

The disadvantages of such crude heating methods must surely be apparent to anyone who has had experience with them. In the case of moulding machines heated with a gas flame the usual method is to maintain a gas flame within the framework of the machine in the space under the pattern plate. It is difficult to keep the flame low enough so that the pattern will not be overheated. Furthermore, the heat from a gas flame is localised, whereas what is wanted is a uniformly distributed heat so that all parts of the pattern will be equally heated. To overcome these difficulties with low flame and localised heat, it is customary to burn a larger flame than is actually required to produce the necessary heat for the pattern and to locate that flame at a greater distance from the pattern plate. This, of course, is an inefficient arrangement since a large part of the heat is wasted. It has an added disadvantage in that the gas fumes are unpleasant for the workmen, and in the summertime the heat is objectionable. Also with this method of heating variable gas pressure makes frequent attention necessary, and in some sections of the country where there is a scarcity of gas in cold weather there may be no gas pressure at all at times when the use of heat is most necessary.

* A paper read before the American Foundrymen's Association.

Using Paraffin to Heat Pattern.

The objections to the use of kerosene torches or tin cans filled with sand saturated with paraffin which are said by some who have used them to be better than torches—must be even more obvious than the objections to gas flames. Aside from all difficulties with the moulds being too hot or too cold, necessity for cleaning and refilling the torches, and general inconvenience, messiness, and crudity of the method, the fact that there is a constant emission of evil-smelling fumes right into the faces of the men working over the moulds has been sufficient reason, in at least one case, for the manager of the plant to apply a more modern method of heating the patterns.

At the West Newton plant of the U.S. Radiator Corporation a considerable number of metal patterns are used from which moulds are made continually throughout the day. It had been the practice at this plant to warm the patterns by means of kerosene torches to prevent the sand from sticking to them, since it was essential that the moulds be perfect. But warming the patterns with kerosene torches was a dirty, smoky operation and not at all popular with the workmen.

Experiments with Electric Heat.

The manager of the plant conceived the idea of applying electric heaters to the patterns, and made preliminary experiments with heating elements from electric sad irons. The shape of these elements prevented their most efficient application to the pattern, and they did not stand up well, but the result indicated that electric heating of metal patterns was practicable.

While in search of more suitable heating elements the manager heard of the steel-clad type of heater. Two of these heaters were secured and applied to the patterns. The results were so satisfactory that now about 15 patterns are equipped with similar electric heaters.

Fig. 1 shows the general shape of the pattern with its supporting carriage. The power is supplied from an ordinary lamp socket through a flexible cord, which is attached to the pattern carriage. In moderately cold weather the heat is used intermittently as the need for it appears, but in extremely cold weather the heat is left on continuously while the pattern is in use. The capacity of the heaters is 600 watts at 110 volts, and the temperature to which the patterns are heated is approximately 32 to 37 deg. Cent.

Applying Heater to the Pattern.

Standard steel-clad heaters of the narrow type, which are in the form of a long, flat strip approximately 20 in. long, $1\frac{1}{8}$ in. wide, and $\frac{1}{8}$ in. thick,

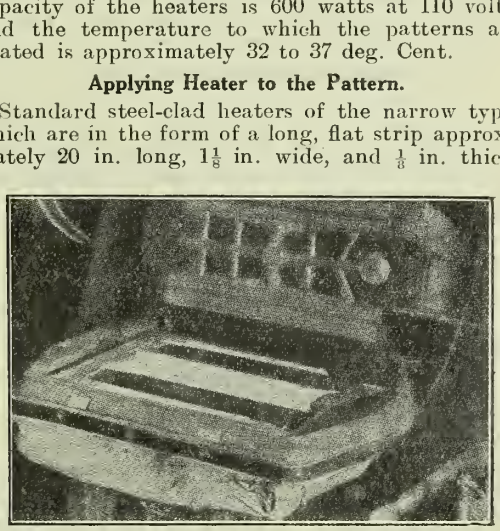


Fig. 2.—Stationary Moulding Machine Showing Plate Removed to Reveal Position of Steel-clad Heater.

are laid in grooves cut in the face of a cast-iron plate which forms the top of the carriage. The heater terminals project downward through holes drilled through this plate, and are wired to a socket on the side of the carriage. The upper surface of the heaters, which are perfectly flat, are flush with the upper surface of the plate, so that when the pattern plate is laid on the top of the carriage the heaters are in contact with it. With the pattern plate in place, and fastened with suitable bolts or screws, the assembly is similar to the

construction of a modern electric iron—the heating elements being firmly clamped between two metal plates, so that the heat from the heating elements will be transmitted by conduction to the working surface. This enables the heaters to operate at a relatively low temperature, and makes the surface of the pattern quickly responsive to the application of heat.

Some of these pattern carriages have been equipped with electric heaters mounted in the space below the pattern plate, but not in contact with it, so that the heat is transmitted to the plate by radiation instead of conduction. This method is not so efficient in utilisation of the heat, and results in slightly greater power consumption and lower heating, but is otherwise satisfactory. It is a cheaper method of installing the heaters, and in some cases it may be the most practical method.

The manager of the plant where these electrically-heated patterns are in daily use has reported that the use of electric heat has been cheaper than the use of the kerosene torches, besides being more satisfactory in other ways, particularly with respect to the absence of obnoxious smoke and fumes.

At about the same time that electric heaters were being applied to the radiator patterns, another manufacturer installed electric heaters of the same type in a moulding machine. As in the case of the radiator patterns, the method of applying the heaters consisted essentially in arranging and supporting them so that they would be in contact with the under side of the pattern plate below the thickest part of the pattern. The heaters were not attached to the pattern plate, but were supported on angles attached to the frame of the machine, and therefore their presence did not interfere with the changing of the pattern whenever required.

The heaters are of the steel-clad type, which consist of slotted ribbon heating elements of high resistance, heat-resisting alloy, insulated with a mica envelope, and the whole enclosed with a sheet-steel casing applied under hydraulic pressure of two tons per sq. in. At each end of the heater the steel casing is extended to form a mounting lug, and has two holes punched in it for the fastening screws. The terminals are at one end of the heater, and are protected with a substantial metal cover.

Fig. 2 shows the pattern plate removed to display the heaters mounted on the angles in the frame of the machine. In order to conserve the heat an asbestos heat-insulating plate was placed just below the heaters to prevent loss of heat by radiation downward from the heaters.

Heaters do not Hinder Operation.

The presence of the heaters did not in any way interfere with the usual operation of the machine or the functioning of the mechanical vibrator, and the entire installation was made without any modification of the machine other than the drilling and tapping of small holes for attaching the mounting angles.

The machine takes a pattern plate 16 × 11 × 2 in. The two heaters applied were each [illegible] in. long, 2¼ in. wide × ¼ in. thick, and had a total rating of 300 watts at 110 volts. Connection to the source of power was made by means of a flexible cord and an ordinary separable attachment plug.

The simplicity, convenience, and cleanliness of this method of heating metal patterns must be obvious. The cost of operation varies with different conditions, such as the size of the patterns, number of moulds made per hour, and the price paid for power. But the cost of operation is a relatively small item in any case, and quite inconsiderable in comparison with the advantages of the method. As a matter of actual experience, in cases of which we have record, the electric method of heating patterns is really cheaper than the methods previously used.

The Controla Engineering Company, Limited, have removed from 47a, International Exchange, Birmingham, to Lower High Street, Stourbridge. The company are the makers of the "Controla" automatic gas controller, for reducing and regulating consumption in connection with furnaces, engines, etc.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

"Making Castings without Feeding Heads."

To the Editor of The Foundry Trade Journal.

Sir,—In your issue of August 17, No. 313, you published an article on the above subject, by Mr. S. G. Smith, which is distinctly controversial. Whilst I am at all times willing to discuss scientific subjects, or facts, with any foundrymen who may be interested in my lecture on this subject, or in my experiments in the same direction, I do not think it will serve any good purpose to enter into a controversy in your Journal on these matters.

I am convinced from my previous experiences that journalistic controversies, no matter how clearly cases may be stated, are apt to lead to misunderstanding and consequent confusion, to the detriment not only to the persons taking part in such discussions, but also to all members of the foundry trade, who might be misled by such articles.

As, however, I should like to make my meaning absolutely clear to the gentlemen in Great Britain who are interested on this subject, I intend to accept the very cordial invitation I received from both Sheffield and Newcastle Branches of the Institution of British Foundrymen, and to speak once more on this subject at either of these places, probably in the early spring of next year. No doubt the definite date of the meeting will be published later, and I hope Mr. Smith or any gentlemen who are interested in this subject will see their way clear to attend, when I shall be pleased to explain as clearly as I possibly can my meaning, and also, if possible, place fresh data before the meeting.

I hope Mr. Smith will agree with me that this is the best course to pursue, in order to minimise the possibility of misunderstanding.—I am, Sir,

Yours, etc.,

Thiais, E. Ronceray.

October 10.

If the writer under the *nom de plume* of "Ajax" will be kind enough to inform us of his identity we shall be pleased to publish his interesting communication.

Iron and Steel Production.

The production of pig-iron in September amounted to 430,300 tons, or 18,600 tons more than in August, and the highest figure attained since February, 1921, when production amounted to 463,600 tons. The output is, however, still only 64 per cent. of the average monthly production in 1920 and 50 per cent. of the average monthly production in 1913. The September output included 123,700 tons of hematite, 137,800 tons of basic, 113,400 of foundry, and 25,900 tons of forge pig-iron.

The production of steel ingots and castings amounted to 555,900 tons in September, a figure higher than in any previous month since December, 1920, when it was 746,600 tons. It represents 73 per cent. of the average monthly production in 1920, 87 per cent. of the average monthly production in 1913, and about 50 per cent. of the steel-making capacity of the country.

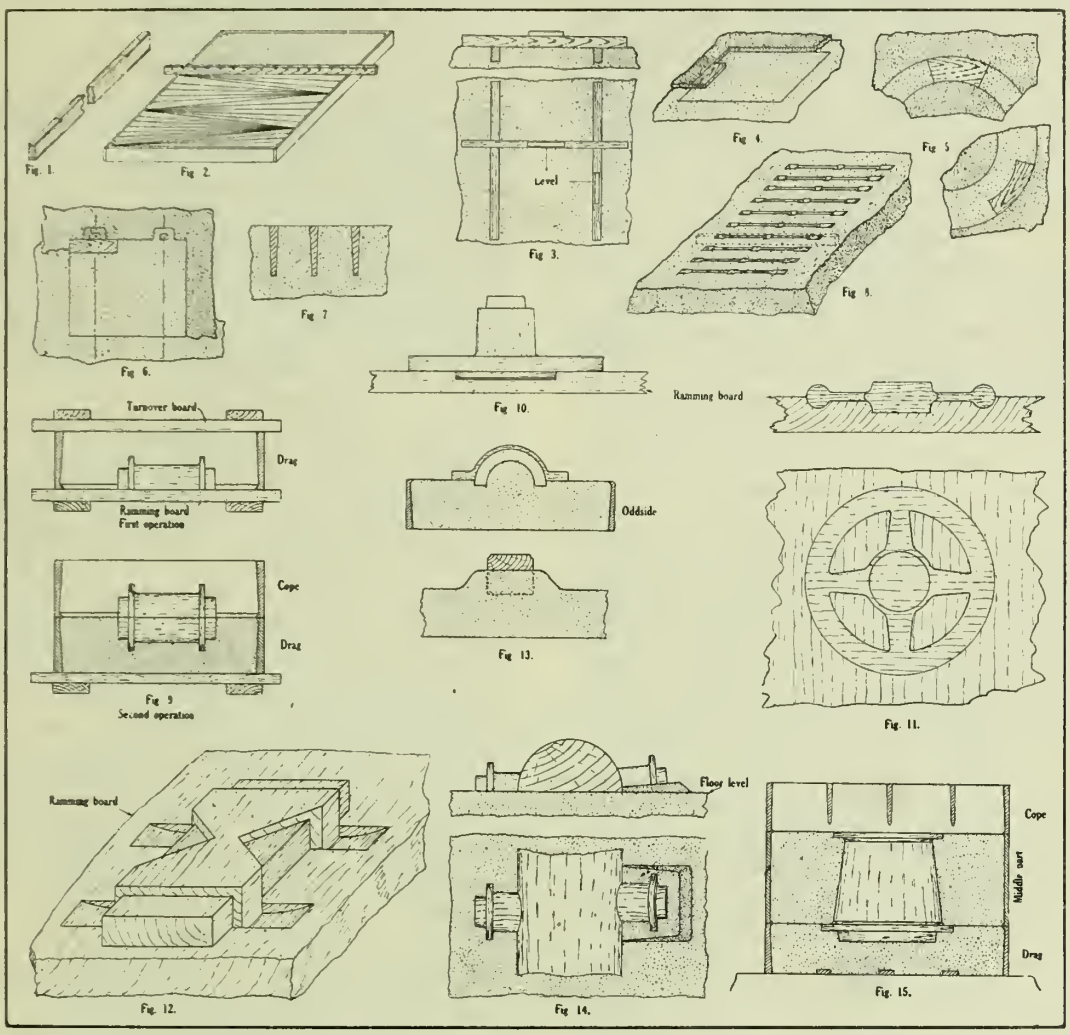
Mr. T. E. Hull presided at the first annual meeting of the West Yorkshire Metallurgical Society, held on Saturday last at Huddersfield. The report stated that, although the Society had not been established a full year, the number of members had reached 45. It had been suggested to the Committee that, by co-operation between members of the Society, a suitably organised scheme of original research could be carried out. The rules provided for no such activity, and in reply to a questionnaire on the matter little expressed opinion was obtained, so that the scheme had been left in abeyance. The chairman said that, notwithstanding the smallness of the membership, there had been efficiency and enthusiasm in a district which could not be regarded as a metallurgical one.

An Apprenticeship Course in Foundry Practice.—XIV.

By Ben Shaw and James Edgar.

GREEN SAND MOULDING.

Moulding in green sand is classified under two main headings, which are known as open-sand moulds and closed moulds. Unless castings are described specifically as open-sand castings, it is taken for granted that they have been made in closed moulds. While green-sand moulds may be either covered or otherwise, the uncovered mould is particularly applicable to green-sand moulding, and it is rarely indeed that a casting is made in an uncovered mould consisting of dry sand or loam. It must not be inferred, however, that green sand is preferred for uncovered moulds because it is impracticable to make them in dry sand or loam, but simply that an open sand casting is the cheapest form of casting, and green sand offers the most economical means for making the moulds. Castings required to be made in open sand are usually of a plain design, and they can be safely cast in green-sand moulds.



Open Sand Moulding.

This method is restricted in its application. If high-grade castings are required, moulds must be covered, and the fact that there is no covering of sand to form the top shape confines its usefulness to work which is flat on one surface, because fluid metal is similar to other liquids, in that it rises in a mould horizontally and the surface of the metal remains flat when the mould is full. When metals are fluid and are cast into moulds, a continual state of ebullition exists during the time the metal remains in a fluid condition, owing to the rapidity with which it gives off heat, and the metal solidifies while it is in this state of commotion, consequently the surface of the metal, when solid, is rough. Usually the commonest of castings only are made in open sand because of these limitations, and they consist mainly of moulders' tackle, such as is used in the construction of moulds or cores, and which includes foundations and lifting plates, building rings, grids, etc. Commercial castings are sometimes made in open sand moulds, when the roughened surface is compensated by their relative cheapness. Such castings as floor or stokehole plates, some forms of footsteps, single or double firebars, and gratings of various kinds, are examples of work frequently cast in open sand moulds. This form of moulding can be used for any casting which has projections on one side only, and when the rough side can be bedded into the ground, into cement, or built into masonry. Invariably foundry tackle is cast in a special open-sand bed, whereas other castings are made as required in the green-sand floor. The size of the open-sand bed varies with the size of the foundry and the character of castings made.

Preparation of Open-Sand Bed.

In a general foundry, covering a wide variety of work, the open-sand bed is prepared every day that a cast of any kind is made, and, under ordinary working conditions, this may mean every working day. The bed is generally raised about 9 in. or 10 in. above the foundry floor-level, and is surrounded by a cast-iron frame bolted together. The top edges of the frame are straight and are set so that they are level. Usually two men are in charge of a large bed, and they are responsible for turning over and tempering the sand each casting day and adding new sand as circumstances demand, preparatory to levelling off, flush with the sides of the frame. The sand is not rammed in the usual way, because, for this kind of open-sand casting, the sand need only be lightly consolidated and tamping with the straight edge which bears

upon the frame is sufficient. The bed should contain sufficient sand in order that when it is turned over it projects above the top edge of the frame and it is this projecting sand which is tamped down and any surplus strickled off. The straightedge is generally of wood, but substantially made, and having hoop iron secured to the parts of the edges which bear upon the frame side, as shown in Fig. 1. The proeess of levelling the bed involves the labour of two men, who alternately operate with the straightedge, while one holds down one end of the straightedge the other tamps the sand, and strickles off any surplus with his end of the straightedge forming a sector of levelled sand with the bearance of the straightedge at ono end as the centre. This method is reversed repeatedly, as shown in Fig. 2, until the whole of the bed has been levelled.

When a special bed is made on the foundry floor the sand is rammed, though not necessarily to the same extent as would be required for a closed mould, and straightedged logs are set in the floor and tested for being level and in tho same plane. No tamping is done with the straightedge in this ease, as the logs can only be used as a guide. Sand is rammed between them and strickled off flush with the top edges of the logs and again tested to make sure that no movement has taken place in the process. The logs are finally withdrawn and their impressions made up to the surfaee of the bed if necessary. The method is indicated in Fig. 3.

Making Open Sand Moulds.

In preparing the moulds for tackle the bed is allocated to the different moulders needing it as soon as the bed has been levelled off. Plates and grids are marked off by means of rough templates or with the aid of laths or trammels. The impressions for grids are stamped into the sand by means of the stamps, but the moulds for plates are usually made up to the required thickness on top of the bed, the surface of the bed forming the bottom of the mould. The patternwork used for such plates is of the most simple character and comes under the category of sectional patterns, supplying a part only of the desired shape, but sufficient to enable the moulder to make the complete mould. For ordinary plates, with lifting staples east in, a rectangular piece of wood, having a thickness slightly in excess of the required thickness of the plate, is all that is needed. The shape of the plate marked out on the bed, is used as a guide, and the sectional pattern used to make up the sand in the manner shown in Fig. 4. The same method is adopted when a circular building plate is required, but the sectional pattern is cut to represent a segment of the plate or, when the plate is wide, and it is desired to make up the sand inside and outside separately, the sectional pattern need not be made the full width as long as the concave and convex sides correspond with the respective markings on the bed. Both methods are indicated in Fig. 5. When snugs are required to be cast on plates, the centres about which they are to be cast are marked on the bed, and a part pattern, corresponding in shape to the snug, is located about the centres as the formation of the mould proceeds, in the manner indicated in Fig. 6. The sand forming the thickness of the plates is always rammed and it is important to make the mould deeper than the desired thickness of the plate because there is the possibility of considerable fin if it is completely filled, which besides being a danger to other moulds, is a nuisanco on a casting.

Although the preparation of a bed is preferable when the foundry floor is used and when the castings are to be made flat, patterns are frequently bedded into the floor and the upper surface tested with a spirit level. Making moulds for firebars to be cast in open sand is an example of such a method. Generally two or three patterns are used because a quantity of castings is invariably required. The sand of the floor is softened and the patterns are knocked in parallel to each other and about 6 in. apart until the top edges are flush with the floor. The patterns are then adjusted until they are level, when sand is rammed about them and is levelled off to form the surface of the moulds, as shown in Fig. 7. The advantage of having two or three patterns is in evidence during the time of stripping and in proceeding with the formation of the moulds. When two patterns are supplied, only one is stripped at a time, the remaining pattern being left in tho sand until the first pattern is again rammed up. When three patterns are used then two can be stripped and rammed up again, and this process is repeated until the requisite number of moulds are prepared, or until it is necessary to commence another row of moulds, when the final pattern is withdrawn and the whole process recommenced. The single pattern is left in its mould as a protection against damage while the sand is being rammed about the next pattern. The moulder further protects the moulds by resting a straightedge or any piece of wood across the mould surfaee and separating the completed moulds from those from which the patterns have not been withdrawn as illustrated by dotted lines in Fig. 8.

It is rarely indeed that special facing sand is used for open sand castings, a good surface being sacrificed for cheapness, and, with very few exceptions, this class of moulding is confined to the cheapest of metals, namely cast iron.

Closed Moulds.

By far the greater number of castings are made in closed moulds, that is moulds which are covered, because their usefulness is not limited as with open sand moulds. All types of castings, whether intricate or not, are more satisfactory if made in a closed mould; indeed, with the majority of castings, it is the only possible way. A closed mould need not necessarily be set with its upper surface in a horizontal direction to be cast, as the body of sand that eomprises the cover becomes part of the mould and it arrests the flow of metal when the mould is filled. When the fluid metal has completely filled the mould the air is excluded and the metal lies quietly against all the surfaces of the mould, providing the venting has been attended to, there is, therefore, no roughened surface on the casting. Not only does the upper surface of a easting, made in a closed mould, compare favourably with other surfaces with regard to the smoothness of skin produced, but it can be shaped and impressions of projecting parts earried in the eover. This is possible because the metal east in a elosed mould is under pressure, which forces it into the top impression and, incidentally, this pressure is responsible for making the texture of the metal more dense, thus providing a stronger easting than is possible from an open-sand mould, other conditions being equal.

Patterns used in the preparation of covered moulds are entirely enclosed in sand, and it is necessary to eonstruct the moulds in parts so that they ean be separated, in order to withdraw the patterns. The number of parts varies with the design of the eastings to be made, and the moulds are referred to as a two-part, three-part, or four-part mould aecording to the number of parts necessary.

Two-Part Moulds.

A mould consisting of a bottom or drag and a cover or cope is known as a two-part mould. This form of mould is used when the design of the casting and the construction of the pattern are such that the pattern can be extracted, when the two parts of the mould are separated without destroying the formation of the sand about it. The shape and area of the mould at the junction of the two parts must also admit any loose bodies of sand that may be necessary to form the internal shape of a casting and without which it would be impossible to withdraw the pattern. A two-part mould is all that is necessary for the majority of castings, because, frequently, parts of a pattern which would prevent its withdrawal are made loose in order that the main pattern section can be withdrawn and the smaller, loose parts removed separately. When this is not possiblo parts of the mould may be made loose and lifted from the joint as mentioned above, or elsewhere in the mould in ordor to free the pattern or to allow for the introduction of cores, but the mould as a whole remains a two-part mould. We shall deal more fully with such instances in subsequent articles, but it is necessary to point out at this juncturo that, with the general run of work, the number of parts used is limited as much

as possible for economical reasons of which box equipment is one of the most important.

Preparation of Two-Part Moulds.

We have previously stated that the major part of a mould is formed in the drag; the exceptions concern those castings which are of such a shape that the junction of the two parts of each mould coincides with the centre of the casting, such as for example cylindrical castings, which are prepared horizontally. Generally, however, the cope is merely used to provide a cover, and the impression it carries is comparatively small, the main part of the mould being prepared in the drag. This method is advantageous, because it is the cope which is located on the drag when assembling the mould for casting, and the reduction in the body of sand due to the necessity of having considerable top shape would render it more liable to collapse when inverted, or, it would necessitate a substantially deeper box part and increased lifting to carry the sand successfully. When cores are required to be inserted in the mould it is better that as little as possible should project beyond the drag so that the pins of the box part will register before the projecting cover core is engaged in the cope, and this can only be accomplished satisfactorily when the greater part of the mould is made in the drag. In the actual preparation of moulds in green-sand either the turnover or bedding-in methods may be adopted, and these methods are equally applicable in the preparation of dry-sand moulds. In green-sand work, however, the turnover method predominates, whereas bedding-in is more frequently adopted in dry-sand work. We shall therefore content ourselves in this article with the preparation of green-sand moulds by means of the turnover method and consider the bedding-in method later.

Turnover Method.

When the turnover method is adopted it means that the drag is rammed up in an inverted position and then turned or rolled over preparatory to making the cope. The method possesses many advantages over bedding the pattern in the sand, because the sand can be more regularly consolidated, and it is more accessible for ramming; less work is required in the formation of a joint for the cope, as, not infrequently, no tool work is involved when the drag has been turned over, and incidentally, the pattern is subjected to less rough usage, and economical consideration often omitted. The turnover method is partjcularly suitable for work, the pattern for which will rest flat upon a board or sand bearance, or, when the pattern is so jointed that part of the pattern can be laid on a board with its joint next to the board. The drag part should also be placed on the board and about the pattern when sand can be shovelled in and the whole part rammed up and sleeked off flush with the bottom. It is at this stage that the drag is turned over and a turnover board may be necsary to support the sand in the drag while it is being inverted. This, however, usually only applies to the smaller box parts that have no bars cast in them. The method is indicated in the two sections, Fig. 9. The board, known as a ramming board, upon which the pattern is laid, is flat in this instance because the pattern, being in halves, one half rests flat. When the drag has been turned over the other half pattern can be located and the cope part set, the drag then becoming the ramming board for the cope. When the joint of the mould is not straight or when the pattern is solid and of such a shape that part of the impression must be carried in the cope then the ramming board should also be varied in order to form the shape of the joint desired, when the drag is rammed on it. If a large number of castings are rquired, and the moulds must be made by hand, a wooden ramming board may be prepared either cut, so that the pattern rests flat upon it, as in Fig. 10, or, to allow the pattern to be introduced into the position until the level portion of the board coincides with the position of the pattern at which the joint should be made, as in Fig. 11, or, it may be recessed to form the joint as in Fig. 12. Apart from machine-moulding very few shaped ramming-boards are now used on the floor or at the bench, because of the expense in their preparation, when only a few castings may be needed. It is more economical to use machines when quantities of similar castings are required, and the ramming-board becomes a pattern or match plate, which we shall consider in connection with machine moulding. When it is not possible to use a flat ramming-board on the floor or at the bench an odd-side or false part is usually prepared to act as a ramming-board, either a box or the floor being used for the purpose.

Odd-Sides or False Parts.

An odd-side is a temporary expedience for supporting the pattern and determining the shape of the joint of the drag prepared on it. It is prepared in a box part corresponding to the part to be used for the cope, or the part of the pattern which is to form the impression in the cope may be bedded in the foundry floor and the joint shaped as required preparatory to locating the drag about the pattern. Usually ordinary moulding sand is used to make odd-sides, and if they have been carefully prepared they can be used a number of times. Plaster of Paris odd-sides may be prepared when many castings are to be made or a special wax-composite may be used. Sand odd-sides are, however, in more general use. A simple illustration of an odd-side for a bearing cap prepared in a box part is shown in Fig. 13, and in Fig. 14 the odd-side shown is for a branched pipe using the foundry floor. In both these instances it is preferable to make the surfaces level in the first place and then lay the pattern or pattern section in position and make up the shapes as indicated. It is frequently desirable that a level surface should be prepared at the outset even when the surface must be cut to admit the pattern, then only that part of the joint which does not coincide with the joint of the box part need be made up. When the odd-side has ceased to be of value as a means of forming the joint, the sand is knocked out, thus it is merely a temporary form of ramming-board.

Three-Part Moulds.

Moulds are prepared in three parts when the designs of the castings to be made prevent them being made in two-part moulds; or, when the work involved would be more easily done by making each mould in three parts. It is for similar reasons that moulds are sometimes made in more than three parts. It is sometimes necessary to use a three-part box for a two-part mould in order to have the depth of two-box parts for the drag, but only one joint is necessary, therefore the mould remains a two-part mould.

Preparations of Three-Part Mould.

A three-part mould is prepared in a similar manner as a two-part mould by means of the turnover or bedding-in methods. Although the drag is sometimes rammed separately in an inverted position when the pattern is jointed, so that this method is possible, frequently the middle part is rammed first in an inverted position, the drag prepared on it, and the two parts are clamped together for turning over to proceed with the cover. The method is illustrated in Fig. 15. When three parts are employed it is the middle and drag parts that form the main impressions. Frequently that part of the mould formed in the drag is very small compared with that in the middle part, and the foundry floor is sometimes used instead of a box part, a method which involves the bedding-in process.

The American Tariff and Solingen.—A Berlin report states that the steel-ware industry of Solingen—the German Sheffield—has suffered considerably as a result of the putting in force of the new American tariff, a large number of orders from the United States having been cancelled. A great decline in the number of new orders from America is also noted. The falling-off in American orders is a severe blow to Solingen, as during recent months about 50 per cent. of the total production has gone to the United States. Apart from the loss of business with America, orders from other quarters are scarce, not only in the steel-ware industry but also in other Solingen works, and a number of firms are already considering the question of slowing down.

The John Surtees Memorial.

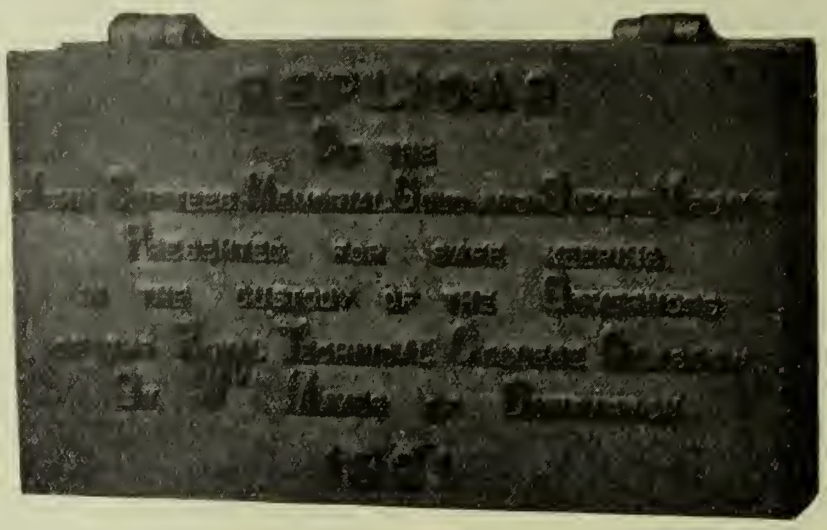
The Newcastle Governors of the above Memorial, in inviting applications from candidates for competition for the medals of the respective classes as provided by the fund, state that they hope that the funds will permit of the awarding of supplementary prizes, therefore they expect that a good response from aspirants to these honours will be forthcoming.

The examination for senior candidates will be based upon the following subjects: (1) A calculation; (2) practical moulding on a sample pattern to be selected by the Governors; (3) sundry other alternative questions to be followed by an oral examination on practical foundry subjects.

Rule XVII.—The Senior Examination shall be open only to Members and Associate Members who have served a regular apprenticeship as moulders and coremakers in a foundry and are engaged as moulders or officials in a foundry at the time of examination.

Note.—The Senior Examination shall be open only to Associates and Associate Members whose apprenticeship has ended not later than the date on which such member reached twenty-one years of age.

Rule XVIII.—The Junior Examination shall be open only to members who are apprentice moulders and intend to continue at the trade as journeymen, officials or principals.

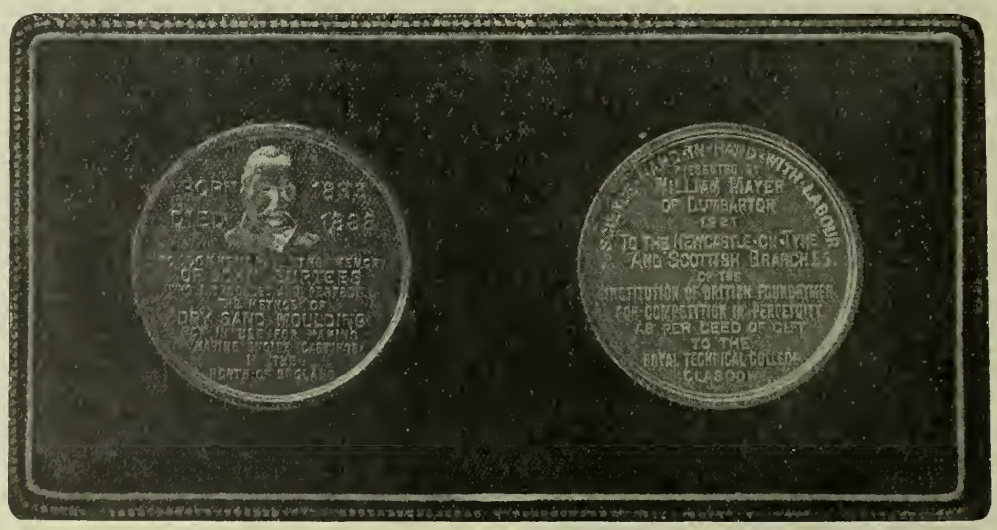


For the junior candidates the following subjects have been chosen: (1) Model drawing of a simple pattern to be selected by the Governors; (2) practical mathematics; (3) simple questions in geometry; (4) practical workshop (foundry) questions. These may be set as a paper, or taken orally, or both, at the discretion of the Governors.

The rules and conditions governing the examinations are based upon the deed of the John Surtees Memorial, of which the following are the most important:—

Each candidate entering the examinations must agree to observe the rules and conditions laid down by the deed of gift, and accept the decision of the Governors as final.

Applications from candidates must reach the Secretary, Mr. H. A. J. Rang, of 2, St. Nicholas Buildings, Newcastle-on-Tyne, not later than October 31, 1922, after which date no applications will be considered. Notice of the date and place of examination will be sent to candidates in due course.


DIED A.D. 1888
THE LEGACY OF JOHN SURTEES
THE MEDAL OF
DRY SAND MOULDING
THE GIFT OF WILLIAM MAYER OF DUMBARTON 1921
TO THE NEWCASTLE-ON-TYNE AND SCOTTISH BRANCHES OF THE INSTITUTE OF BRITISH FOUNDRYMEN
FOR COMPETITION IN PERPETUITY AS PER DEED OF GIFT
TO THE ROYAL TECHNICAL COLLEGE GLASGOW

Rule XIV.—The Competition shall be open only to Members, Associate Members and Associates or the equivalent degree of membership as they may be designated from time to time by the rules of the Institution of British Foundrymen, subject to the following qualifications and conditions.

Rule XV.—Competitors must have been Members, Associate Members or Associates of the Institute of British Foundrymen, Newcastle or Scottish Branch as the case may be, for not less than twelve months at the time of the examination, save and except in the Junior Class, in which Class this condition may be suspended at the discretion of the Governors concerned.

Rule XVI.—There shall be two grades of competition, namely, Senior and Junior.

It will be remembered that the funds for this memorial have been provided by Mr. William Mayer, of Dumbarton, a past-president of the Institution of British Foundrymen. We illustrate above both the medal and the lid of the case which contains it.

It now remains for other generous-minded foundrymen to follow Mr. Mayer's lead so that other branches may utilise the memory of John Surtees for disseminating foundry knowledge.

A London syndicate has acquired a controlling interest in the Mill Close Lead Mine, near Matlock. The intention is to develop the mine by the provision of additional capital, etc.

Foundry Cupolas.

By E. A. Roper.

It is now generally admitted that foundry proprietors and managers are taking a more genuine interest in the cupola as an important factor in foundry efficiency, and the object of this article is to give point to that interest, by discussing various details in cupola design, and their effect on its working.

Recent research has proved that the chief difficulty in providing the correct iron for the moulds is that there are so many variable factors in the general problem, which are inter-dependent, and that this problem is greatly simplified with a cupola plant that can be relied upon to give practically regular working results day by day.

This calls for a well-designed plant by engineers who specialise in this unit, after a careful consideration of the work for which it is required, experience having shown that the old idea that anybody could rig up this themselves, and thus save money, is not a practical policy in the foundry of to-day, such a plant too often proving an "expensive luxury."

All cupolas, of course, embrace a steel shell of suitable diameter, with a refractory lining, suitable for the high internal temperature, and of such a width that will prevent the radiation of heat in the portion below the charging hole.

As the heat is greatest in the melting zone and also the need for preventing radiation, a well-defined lining should be widest at this point. The highest quality of material obtainable is no doubt the cheapest, as repairs and re-lining are costly, and the material from which it is made should be free from an excess of lime and alkalies, as they can be distinctly detrimental.

Many people with large cupolas on heavy duty use hollow cast-iron lining blocks, which start about 2 ft. above the melting zone, and are supported on the bricks below, and with a strong internal angle iron ring on the cupola shell. This being fitted where the charge is constantly moving, cuts down the cost of repairs, as it gives a more durable wearing surface. There is, however, a greater loss of heat through radiation with this practice, which means increased fusion coke to set against this economy.

Better practice would be obtained with a higher type of refractory which combines a better wearing surface with low conductivity. Cast-iron blocks can be used with advantage in the region of the charging hole up to 3 ft. below it to halfway up it, as the heat lost here through radiation is practically waste heat, and ordinary fire-bricks are usually badly damaged from the throwing in of the charge.

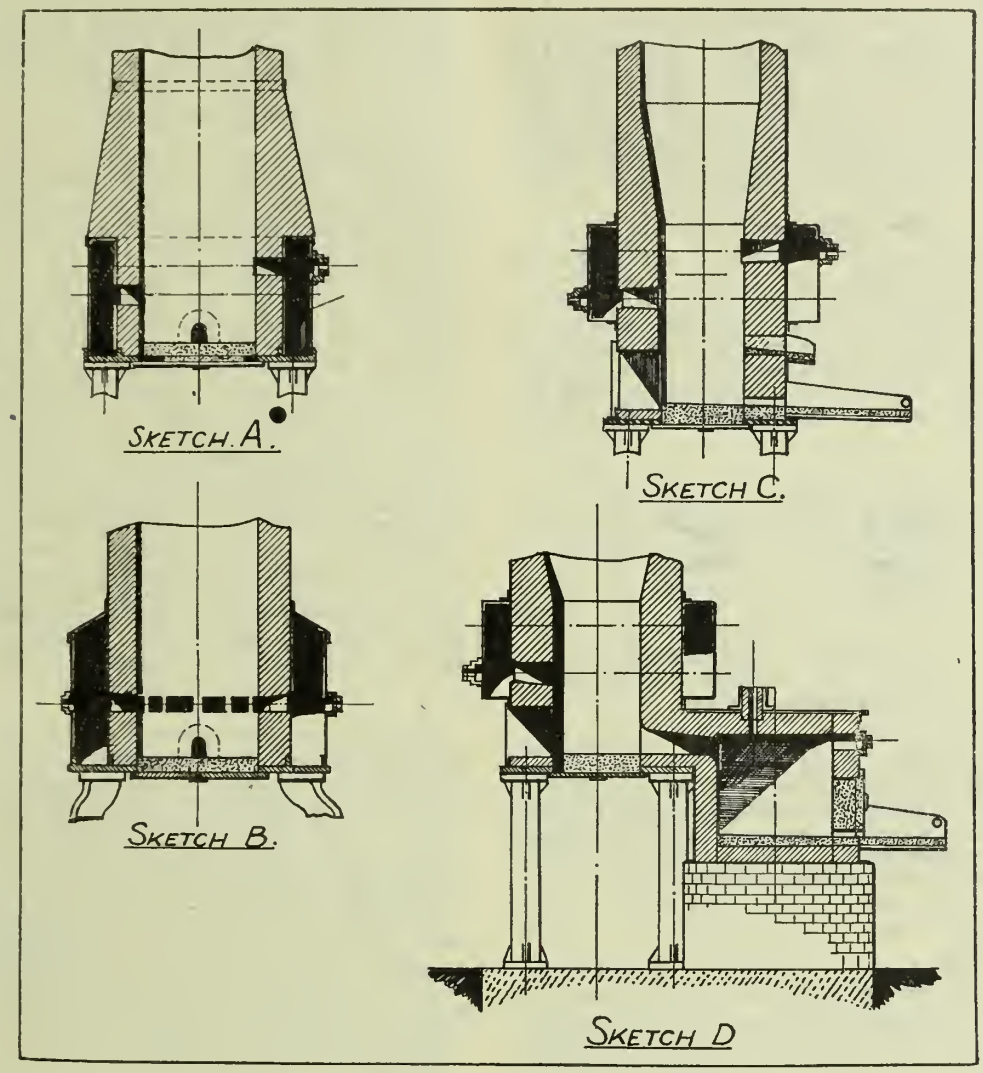


Fig. 1.—Illustrating a Few Types of Cupolas.

Reducing Cupola Chimneys.

Where it is necessary to add 10 ft. or more to the standard height, and particularly where a spark arrester has to be fitted, a substantial saving in first cost can be effected by reducing the diameter of the chimney above the charging hole, as this reduces the weight of the steel shell, lining, and the size of the spark arrester required.

There is no disadvantage in this practice if the reduction is not more than $\frac{1}{3}$ of the diameter for cupolas over 5 ft. diameter and $\frac{1}{4}$ for cupolas below this. If too great a reduction is made, however, the flames will flash out of the charging hole, owing to the increased velocity at which they

have to pass up the chimney and the pressure necessary to produce this. With the reduction as suggested no trouble is experienced at the charging hole, and the only result is that the sparks, etc., are carried to a greater height above the top of the cupola, and spread over a larger area when they fall. Where a spark arrester is fitted, the increased velocity helps this to operate, as the sparks are usually deflected from a plate, or by a right angle, or U-shaped bend in the chimney.

Drop Bottoms.

Drop bottoms are now a generally accepted feature for all grades, with the exception of malleable work, the hearth being made with ordinary floor-sand, rammed on to the drop-bottom doors, which are hinged on the underside of the bottom plate which carries the cupola, and held up with a draw-bar, or other means.

This provision greatly facilitates the removal of the unburnt coke bed and slag at the end of the blow, as the doors can be opened, allowing this to drop out at the bottom. This will drop quite clean if the slag is in a liquid state, and for this purpose the doors should be opened as soon as possible after the last metal has been tapped, and a small amount of blast left blowing through the cupola to maintain it hot until it has been done.

Blast Volume and Pressure.

The most essential features in the design are those relating to the introduction of the blast to the bed, and the volume and pressure of blast at which the cupola is required to work. This should be introduced in such a way that the coke bed is uniformly heated right across, so that as little chilling of the slag as possible occurs, and the fusion coke can be burnt uniformly in the melting zone.

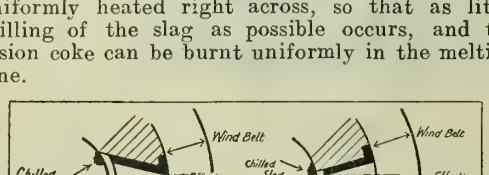


Fig. 2.—Illustrating how Chilled Slag soon Affects the Effective Area of Converging Tuyeres.

Various means are employed for this purpose, numerous tuyeres, equally spaced round the cupola in one or two rows are used to get a good distribution. The tuyere openings are splayed on the inside to spread the blast over a larger area of the coke, thus reducing the chilling effect on the slag, and also by reducing the internal diameter of the cupola at the tuyeres, as shown at C and D, Fig. 1, so as to introduce the blast nearer to the centre of the bed.

Blast Volume.—Since cupolas are in use on all grades of foundry work, this will only be a constant when working on one regular grade, and varies as the fusion coke required on the different classes of iron melted. As this varies from approximately $1\frac{3}{4}$ to $2\frac{3}{4}$ cwt. per ton, the volume of the blast should vary from 28,000 to 44,000 cub. ft. per hr.

The point of importance in connection with blast volume is that the correct amount to burn the fusion coke should be supplied, and any more, or less, is interfering with the proper working of the cupola, and one of the chief causes of indifferent results.

A cupola and blower may be installed suitable for general work, and used for a lower grade, providing the resistance in this is correct, but a blast-regulating valve must be fitted to the cupola, and a volume gauge available for use, until the attendant is familiar with the adjustments necessary to this valve.

To ensure that an equal volume of air shall be distributed by each tuyere to the bed coke, an annular steel wind-belt is built round the cupola, and this should be of ample capacity, in order to act as a receiver, and not merely as a convenient form of connecting pipe to the tuyeres. The area of a vertical section of this belt at any point should be at least equal to the total area of the tuyeres, and preferably one and a-half to double this.

In the outer plate of the wind belt, opposite each tuyere, is fixed a sight-hole fitting for observation, provided with a loose lid which enables the tuyere to be cleaned when necessary. In the bottom of the wind belt, and opposite a tuyere, a hole can profitably be arranged, 3 to 4 in. dia. and covered with a renewable lead disc, held in position with a ring casting and studs. This fusible disc is melted by the metal or slag, if allowed to get too high in the cupola, and through the tuyeres, and gives notice to the furnaceman to tap out before the wind belt is choked or damaged. The other necessary fittings on the wind belt are a blast-pressure gauge, provision for periodically attaching a volume-gauge, and hand holes in the outer plate of wind belt near the bottom to facilitate cleaning out the dirt which collects there. These hand holes should perhaps not be described as necessary, but as a useful addition.

Blast Pressure.—While the blast volume must be constant for each grade of iron melted, ordinary grades of cast iron can be melted at almost any blast pressure. By using a high-pressure blast, more coke is consumed per hour per sq. ft. of the melting zone area, and therefore the pressure at which the blast is supplied materially influences the rate of melting.

When deciding the blast pressure, the class of the casting required and the life of the lining are the chief considerations, as high pressure gives a higher temperature in the melting zone, with more rapid melting, harder metal, and with a greater burning or wear of the lining.

For general work the author recommends as suitable, the following blast pressures:—For cupolas of less than 3 ft. external dia., 10 oz.; for 3 ft. but less than 4 ft. dia., 10 to 12 ozs.; for 4 ft. but less than 5 ft. dia., 12 to 14 ozs.; for 5 ft. but less than 6 ft. dia., 14 to 16 ozs.; for 6 ft. but less than 7 ft. dia., 16 to 18 ozs.; and for 7 ft. and including 8 ft. dia., 18 to 20 ozs. pressure. The higher pressures are necessary in the larger cupolas for maintaining a practically even pressure to the centre of the bed.

While it may not be incorrect to speak of the blower as producing so many cub. ft. of blast at a given pressure, it is less misleading to speak of this as producing so many cub. ft. against a given resistance, as this resistance has to be produced in the cupola, or the pressure cannot be maintained.

Tuyeres.

A further important point is that obviously for uniform working. It is necessary to maintain a constant blast volume at a uniform pressure, and this pressure is produced by the resistance of the charge in the cupola, plus the resistance in the tuyeres. The resistance in the cupola charge will vary directly with the height from the tuyeres to the charging hole, the cupola being kept charged to this point. If the volume supplied is kept constant, and the resistance in the tuyeres will vary as their total effective area, as is illustrated in Fig. 2. To produce a substantial resistance in the tuyeres these would have to converge to a small diameter, where the blast enters the bed.

This would be most marked in a large cupola, with a large charging hole, where a relatively high pressure is required, and, further, all cupolas with different heights of charging hole would require different diameters of tuyere-outlets accordingly.

A converging tuyere is, however, bad practice, as the area of the outlets is soon reduced with chilled slag, which either reduces the volume or increases the resistance, according to the type of blower used, causing a constant variation in working conditions throughout the blow as the tuyere is restricted or cleaned.

Regular working conditions, therefore, can only be obtained by producing all the necessary resistance in the cupola charge. This is done by having the charging hole at the correct height, and by using splayed tuyeres of ample area for the blast required, so that partial slagging does not interfere with the effective area. The chilling of the slag is also reduced to a minimum, by thus spreading the blast over a larger area of the bed.

Cupola Wells.

The cupola well should be designed to carry the amount of metal required before tapping out, and

the slag formed. As the well is already full of bed coke, only 40 per cent. of the total capacity may be estimated for this purpose, and this amount should not be overstated, as it means a large proportionate increase in the bed coke required.

It should be possible, however, to be able to carry at least one complete iron charge, and preferably two in the well of the cupola, to ensure a complete mixing of the metal before being tapped. The usual means of storing this amount of metal before tapping is by the use of a receiver, a representative type of which is shown at D, Fig. 1, from which it will be seen that the depth of the well in the cupola can be cut down to a minimum, thereby reducing the bed coke to a minimum, and no coke being present in the receiver, ample storage capacity for molten iron can be obtained.

Better working conditions are also obtained in the cupola by the use of a receiver, as the slag runs straight from the cupola into this, and does not gradually choke up the bed coke, as in the cupola without receiver, where the slag is carried up and down through this, as the metal is tapped and held.

Cupola Types Discussed.

The essential difference between the type as shown at A and B and that shown at D and C, Fig. 1, is that the former have a straight-lined internal diameter and the latter has a lining reduced at the tuyeres, with a tapered part in the melting zone. This means a large internal diameter in the bottom in A and B, and the required capacity for storing metal is obtained with a very shallow well, necessary in this case to keep down the weight of bed coke required.

In cupolas of type C and D, with a reduced internal diameter, a higher well is required for the same capacity, and this leads to the difference in the two designs. In A and B the tuyeres are set so low that there is no room between the bottom plate and the underside of the wind belt for the fettling hole, slag, and tapping spout, and the wind belt is therefore carried right down to the drop-bottom-plate, and archways are cut through this for the fettling hole, etc.

In cupolas C and D, with the deeper well and higher tuyeres, the wind belt is self-contained and fitted above the fettling holes, etc., where it is less likely to be damaged by being burnt, and forms a more robust construction.

In type A a thicker lining in the melting zone is embodied, but the internal wind belt is a doubtful feature, as no advantage can be obtained by attempting to heat the blast at the expense of heat radiated from the bed or the melting zone. The main object is to conserve all the heat possible in this region, and a thicker lining should be used if there is any appreciable radiation here, and any heat used for heating the blast should be drawn from the waste heat delivered above the charging hole.

An internal wind belt is also open to the disadvantage that any leakage of wind will be inside the cupola and behind the lining, where it is difficult to detect, and would cause considerable trouble if it found its way to the slag-hole or tapping-hole.

In type B a single row of tuyeres is used with a practically continuous tuyere opening inside the cupola. While good results can be obtained with a single row of tuyeres in a large internal-diameter cupola, the author is of opinion that this practice is not satisfactory when applied to a cupola reduced at the tuyeres as in types C and D. The guiding principle is that, provided the correct amount of blast is supplied for burning the fusion coke, the only other object is to distribute the blast over a sufficient area of the bed as will prevent the chilling of the slag.

In types C and D the natural form of lining is used, with a thicker lining in the melting zone and a reduced area of bed at the tuyeres. This brings the blast nearer the centre of the bed, and a lower blast pressure can be used than in A and B. With this arrangement a double row of tuyeres is required to distribute the blast over two cross-sectional areas, the blast entering through the bottom tuyeres being highly heated before mixing with the cold air entering through the top tuyeres. A double row of tuyeres has also this further advantage that the top row can be shut off if the melting zone is allowed to get too low, which lowers the normal height until this is remedied.

In conclusion, cupolas A and B have a further disadvantage compared with types C and D. The drop bottom doors are large and cumbersome to handle, and more sand and time are required to make up the bottom, and the only advantages offered are that the height of the melting zone relative to the bottom of the cupola is reduced. This reduces the height of the charging hole correspondingly, and the molten iron in the well is stored a little nearer the melting zone, which is the hottest point in the cupola.

The German Iron and Steel Industry.

It is reported that a financial group composed of Luxemburg, French and Belgian interests is in negotiation for the acquisition of the majority of the shares in the Becker Steel Works Company of Willich. Prominent Luxemburg interests were formerly connected with the Becker undertaking, and it is assumed that it is now desired to resume these relations. The Company owns iron-ore mines in operation in Luxemburg, and its works lie in the area of Belgian occupation, as also does the big Friedrich Heinrich Colliery. It is also said that an American group desires to gain an interest in the concern through a Dutch financial firm.

The Friedens mine and the Friedens works of the Upper Silesian Railway Requirements Company now form part of Polish territory, and the Company's coal basis has thereby been curtailed. The directors have now decided to acquire the majority of the shares in the Donnersmarckhütte, whose mines and works continue in Germany, and which will be able to restore the lost coal basis for the Gleiwitz and the Zawadzki iron works.

Herr Hugo Stinnes and the Austrian Alpine Montan Company, together with the British Hungarian Bank, have formed the Ferro Company at Pesth with a capital of 10,000,000 Hungarian crowns, and the South Slavian Montan Syndicate at Agram, for the purpose of promoting the sale of the products of the Austrian Company and of those of the Rhine-Elbe Union, in Hungary and the Balkan countries. A similar sales company is also shortly to be constituted for the Rumanian market.

The Hugo Stinnes group has concluded an agreement with the Leptak (Hungarian) Iron and Machinery Company under which the share capital of the latter will be raised from 100 to 180 millions of Hungarian crowns, and 80 per cent. of the increase has been taken over by the former. Besides Herr Stinnes, representatives of the Deutsch-Luxemburg, the Gelsenkirchen, and the Bochum Union Companies become members of the board of the Leptak Company, which will now also promote the export trade.

Company News.

A summary of the financial results of various companies in 1921-22 is given below in marks, the figures for the previous year being shown in parentheses :—

The United Königs and Loura Works.—Gross profits, 96,500,000 (34,580,000); net profits, 80,333,000 (22,040,000); placed to reserve funds, 62,800,000; dividend at rate of 30 per cent. (10).

Menden and Schwerte Iron Industry Company.—Written off for depreciation, 218,000 (761,000); net profits, 2,750,000 (2,960,000); dividend, 25 per cent. (25).

The Bosperde New Rolling Mills Company.—Net profits, 4,500,000 (1,500,000); dividend, 50 per cent. (30).

Carlsruhe Machine Construction Company.—Net profits, 28,440,000 (10,960,000); dividend and bonus, 50 per cent. (30).

Sir W. G. Armstrong, Whitworth & Company, Limited, have taken up the manufacture of steam and oil road rollers and other road-making machinery, including drying and mixing plants.

"White Iron Ore."—Privy Councillor Krusch, at the recent German Geological Congress, communicated the results of his investigations of the diluvial iron ore to be found in the extensive peat bogs in North-Eastern Germany. The peat is mingled with a whitish clay, which contains a considerable percentage of ferrous oxide. The author is studying the question of how this large source of iron ore can be utilised on a commercial scale. In the meantime he proposed the name of "white iron ore" for the deposit.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

Mr. Haigh's Presidential Address.

At a meeting of the Lancashire Branch, held in The Manchester College of Technology on Oct. 7, Mr. J. Haigh delivered the following presidential address :—

Gentlemen,—In addressing you this afternoon I do so with a great deal of pleasure and with a certain feeling of diffidence. I consider it a great honour for any person to be the President of the Lancashire Branch of the Institution of British Foundrymen, and can assure you of my appreciation of the honour you have done me in electing me to this office.

Evolution of the Modern Foundryman.

Foundry work is always fascinating, even if it is accompanied by a certainty of worry. Undoubtedly the art or craft of a foundryman ranks very high, and it is the duty of all to see that the standard is maintained. Unfortunately, and for some inexplicable reason, the foundry industry until recently did not attain that status to which it rightly belonged, and in thinking over this matter, one is rather driven to the conclusion that the neglect was probably due more to the foundryman himself than to any other cause, and probably one reason for this was the Bohemian character of the old craftsman.

Founding is more of an art than any other of the industrial operations, and whilst the older craftsmen were real artists much of the same spirit remains to-day. The glorious uncertainty connected with the making and casting of a mould, calls forth qualities which a merely mechanical operation, however intricate or clever cannot produce, and I wish to make an appeal to all interested in founding to cultivate and develop the artistic and imaginative side of the business, particularly amongst the younger men and boys.

At the present time, when everything tends to become automatic and mechanical, the art and craft of founding stands apart and refuses to be coerced, and it will be a long time before the complete making of a casting becomes a purely mechanical affair. It is granted that the production of certain types of castings lend themselves to mechanical methods, but we have not yet arrived at the stage where the skilled moulder is looked upon as a curiosity and out of date.

After a mould is made, there is the pouring or casting to consider, and it must always be remembered that a mould is tested by the actual pouring of metal. Many a nice-looking mould has been spoiled by the metal.

Recruiting Personnel.

Much has been said about the failure to attract boys into the trade. It is our duty to represent the trade in its true light. Though there are many objectionable features and much that is uncomfortable in the business, it is not at all sure that these things constitute the real reason why there are not more applicants for situations. We are paying the price of neglect in the past, due to influences both inside and outside the foundry, which looked upon the foundry as a place of evil reputation, of bad smells, and bad language, and to which a lad went when he could not get a job elsewhere, or as an accident.

Growth of Foundry Science.

We are suffering from a lack of imagination which originated 20 or 30 years ago, or probably longer, and about that period when the founding industry in this country touched its lowest depths socially, the minds of men were moving, as they ever do, towards higher things, and time and the need produced the men. So in 1904, nearly 20 years ago we find a small number of men deeply interested in the conditions then prevailing and desirous of improving both the technical and scientific as well as the social side, meeting together to discuss ways and means, and from that meeting came the British Foundrymen's Association, which in fullness of time obtained a Royal Charter, and is now the Institution of British Foundrymen, an organisation which has done more to enlarge our vision and to re-create the craft than any other cause.

When we examine the improvement on the purely scientific side, the results are remarkable, and whilst a chemist, and particularly a chemical laboratory, were regarded as a luxury twenty years ago (and in many cases are to-day) we now regard them as being necessary to the regular and accurate production of castings metallurgically. The increased interest taken in metal mixing, sands and facings, and the information available, indicates the progress made. We are well aware that the laboratory cannot tell us many of the things we would like to know, and in many cases does not give the assistance desired; this is often due to the lack of practical experience on the part of the chemist, or to lack of appreciation and inability to use the information available on the part of the practical man.

The lines of demarcation are however growing less, and both sides are being forced together in the common good of the whole.

Advancement has also taken place in other directions. The increasing use of moulding machines, which has enabled us to maintain and increase production in spite of many adverse conditions, shows that the foundry industry generally is now alive to the advantages of machinery, particularly that type of machinery which makes it possible to obtain increased output, with less fatigue for the workman.

Available Craftsmen.

The fallacy " that the introduction of machinery means the reduction of the number of skilled men employed," has been completely exploded in the foundry, and in normal times (present times being abnormal) the number of skilled moulders available is not too great for requirements.

What has taken place, and probably will do so to a greater extent in the future, is the grading of workmen, that is, the highly-skilled moulder will do highly-skilled moulder's work, and those of lesser skill will do the less skilful work, and it will be possible to find work for them according to their ability.

I should have liked to speak upon the education and training of young foundrymen; the subject has, however, been recently dealt with by Mr. A. A. Liardet, the West Riding Branch President, I will content myself by asking you to read his very excellent paper, entitled " The Training of a Foundryman," in which he goes into the subject in a very comprehensive manner.

The subject of training is a very difficult one, and as an Institution we must not forget that the future of the industry rests with the trained and educated man, and no effort should be spared to induce the younger men in our ranks to undergo the necessary training and hard work which is essential to success. I should like to see a serious paper written upon the Training of Foundry Foremen. I am personally satisfied that the higher administrative positions in our foundries will be most satisfactorily filled by the highly trained practical men, rather than by the purely scientifically-trained men.

What is Being Done at Present.

As many of you are aware, committees have met to consider the important question of test bars, and a good deal of work has been done. At the moment their work is not completed, but it is hoped before long, as a result of their labours, to standardise tests and test-pieces and to place the whole question upon a more satisfactory basis for all concerned.

The year 1921-1922 has been noteworthy for our Institution for many things, and so far as this branch is concerned one event in particular, I refer to the gift of the " Oliver Stubbs " Medal, and its first award.

Those of you who have studied the figures relating to the Institution will find that in 1904, the year of its inception, we had 38 members. This year, 1922, we have a total of 1,505, truly a creditable record.

The three outstanding features of the year are:—(1) The granting of the Royal Charter; (2) the gift of the "Oliver Stubbs" Medal; (3) the Foundry Trades Exhibition held in Birmingham.

So whilst we are apt to belittle our accomplishments and to speak with becoming modesty, the work goes forward and we find something has been done.

When Mr. Robert Buchanan, in June, 1918, read a paper at the Sheffield Conference upon a "National Information Bureau for Foundrymen," I do not think he anticipated that within the next three years the nucleus of such a bureau would be in existence, and yet such is the case.

The paper met with a certain amount of criticism, not as to the advisability of a bureau, but as to who should finance it and undertake the work. With the formation of the British Cast Iron Research Association, the question was to a certain extent solved, as such a bureau became one of the first necessities.

I quote this case merely to illustrate the point that progress is taking place and that many of the things desired are being slowly attained.

The formation of the B.C.I.R.A. will, if proper support is forthcoming, prove a great help to the ironfounding industry, particularly to the smaller firms who cannot carry out any extensive research of their own, but who need the best information available. It will be the privilege of the larger firms to help financially. I trust all our Members will give thoughtful consideration and support to the Association, as it is only by co-operative effort that an Association of this description can be successful.

What of the Future?

I am aware that the present time is a very difficult one, probably the most difficult and critical time that the industry has ever known. Great courage and patience are needed if we are to come out successfully, and I believe these qualities are being manifested every day by those in charge. The end of the hard road is not yet in sight, but it is up to all of us who have any power or authority to use it wisely and soberly. If we do this the Institution will render good service to the founding industry and to the country generally.

From the few figures which I have given you, you will appreciate the growth of the Institution which has taken place, but we have not yet reached our highest desires.

Considering the work done for the founding industry, I do not think it unreasonable to put forward the suggestion that we ought to have at least one member in every foundry.

When this is accomplished we shall be able to go forward to the attainment of many of the ideals for which this Institution stands.

I trust during the coming year the gloom which now hangs over our industry may break, and that the warm sunshine of prosperity may appear again to all of you.

Vote of Thanks.

Mr. O. Stubbs, in proposing a vote of thanks to Mr. Haigh for his address, said it was of the kind which he anticipated, containing many practical suggestions. With regard to future developments it was not necessary, nor desirable, that new societies should be formed to do work which came within the province of the Institution. It should also be kept in mind that the object aimed at was the education of the practical men in the shop who did the work, and they should be taught in language which they understood. Much good would be done by holding joint meetings occasionally with kindred Associations, for instance, the Manchester Association of Engineers. He also thought something should be done to obtain new members, in spite of the bad times. There ought to be more members, and they would soon be got if, as he had said before, every member would make it his business to bring in someone else. Very often when the nominations were examined it appeared that this work was left to a small circle. As far as the General Council were concerned, they would be delighted to do anything in their power for the Lancashire Branch.

Mr. Sydney Smith seconded the vote of thanks, which was passed unanimously.

COVENTRY BRANCH.

At a meeting held on October 4 Mr. G. E. Roberts delivered the following address:—

Presidential Address.

Gentlemen—

In considering the question of accepting the presidency, I could not help feeling my own limitations for the office, especially when considering the achievements and technical knowledge of the previous presidents, and I feel I can hardly do better than to give a few random thoughts on foundry work in general, hoping that the restraint that has usually followed presidential addresses may be cheerfully abandoned, and lively discussion followed on any interesting points that may be raised.

Compulsory Technical Training of Foundry Youths.

The first thought that comes to my mind is the difficulty experienced by most foundries in connection with the training of boy labour. It has not been my experience that there is any real difficulty in securing such labour willing to take up foundry work under ordinary rule of thumb methods, but there is a general unwillingness of youth in foundries to take up the study of foundry work in its more technical aspects. The reason is not far to seek, but nevertheless an effort to effect a remedy should certainly be considered. In the first place the arduous work connected with foundry life can hardly be expected to appeal to the more refined and highly educated youth. The dirty work and heat make no appeal to such, and the type of young worker that comes into the foundry is the ordinary boy who merely wants a job, and finds himself more or less accidentally in a trade to which he has given no serious thought. For such as these—and we must take the foundry youth as we find him—I am of the opinion that compulsory training of a more technical character should be given than could possibly be acquired in the workshop only. It can be truthfully stated that there are many difficulties surrounding such a problem, but there must of necessity always be difficulties to overcome before success can be achieved in any phase of life: and it can be proved that in other countries scientific training goes hand in hand with workshop experience, however humble the circumstances of the worker may or may not be. In Germany, at any rate prior to the war, every young worker engaged in a trade was compelled to study the theoretical side of such trade during working hours.

Such training, in my opinion, should either be a charge on the industry concerned or the State itself should make some provision whereby such knowledge may be gained by the young foundryman. Such an arrangement would, in my judgment, prove of inestimable value to the industry in which we are all interested. It would in time give us fewer waster castings, because the worker would have acquired knowledge quite beyond that possible in the mere manufacture of castings by rule of thumb, and the higher degree of skill of the moulder would be a great gain in trade prestige. This would inevitably result in the trade making a wider appeal to boy workers of higher preliminary education. I think that the higher the competitive skill in any trade the wider the appeal such trade makes to those seeking an interesting career.

I very much regret that the old system of indentured apprenticeship is not more in vogue. If it were, there would be less difficulty in getting employers to stand the cost of boys' time spent in technical training at local schools. In my judgment the cost of providing education necessary to make a youth technically proficient in his trade should be borne by the State, and the payment for time lost in so doing during working hours should be borne by the employer. No employer, however, could be expected to carry the cost of so doing unless there were some guarantee that the youth would not immediately leave his employ when trade improved, and labour scarcity enabled some competitor to make a higher bid for the boy's services. Wages should therefore be stabilised according to age without excluding merit bonuses.

Such training schools as may be devoted to the education of the young apprentice should be

equipped for the purpose of proving technical statements, with a moderate amount of tackle for practical demonstrations. In addition I would strongly urge that all educational establishments be provided with technical libraries, to which free access and borrowing leave be given to all scholars interested in their contents.

Patternmaking Defficiencies.

I cannot help thinking that the worker in this branch of foundry work is not so well trained as he should be, considering the length of apprenticeship which has to be served before the patternmaker can be considered efficient. While I do not wish to emphasise glaring blunders in patterns, such as undercuts and tapers cut in the wrong direction, I would draw attention to the insufficient knowledge which patternmakers seem to have of the various metals of the casting for which patterns are made. It may be that the malleable foundry business is particularly unfortunate in respect to patterns which come its way, but it is frequently found that there are sharp right angles instead of the pattern having a good radius or fillet, making it impossible to produce castings without searing until the necessary fillet is provided by waxing up the patterns, fitting leather fillet or trowelling the mould after withdrawing the pattern.

Another grievance which foundrymen have against the patternmaker is caused through his inability to decide where certain types of castings should be run. The considerable contraction and heavy section of some castings which we have to manufacture make it imperative that we arrange large feeding knobs to insure soundness in the centre of some of these heavy sections. Yet we often find that the patterns are so made that we ourselves have to make metal pattern run-offs, and practically do the patternmaker's work all over again. It seems to me that the only possible way in which a patternmaker can be expected to be fully proficient at his trade, and by this I mean capable of producing patterns which will work without alteration when put into the hands of the moulder, is for patternmakers to have a definite period of training in the foundries during the period of their apprenticeship.

Another little trouble which we have is with respect to cores not being made self-centering. In the majority of patterns core prints are left precisely the same diameter as the cored hole. In the case of vertical cores, when the moulder places the top half of the boxes in position, there is no automatic method of making the vertical core locate itself centrally in the top print; and the cored holes come out of position through it being a poor fit, whereas a taper print would guarantee that this trouble would be obviated. A taper print prevents any sand being brought down when closing the boxes and guarantees a centrally placed core. When speaking of taper I refer to a much larger degree of taper than is usually considered sufficient by the patternmaker.

Balancing Prints Require Study.

Another grievance relates to the subject of balancing prints; and this is so important that I would commend the matter to the favourable consideration of patternmakers at large. The majority of balancing prints are extended outwards to such an unreasonable extent that the number of patterns which can be placed in a given size of box is considerably limited. If such balancing prints were shortened and widened the balancing effect would be the same, and the number of castings which could be placed in a given size of box would be considerably augmented. It will be readily admitted that the greater the number of patterns that can be placed in a box the lower the productive cost of the castings. It is really surprising that this detail has not received more consideration from the patternmaker, because while it may mean a little more work for him, the cost of producing castings is thereby considerably lower. There also are instances where prints are forgotten altogether. For instance, the pattern exhibited is painted at one end and, judging by the core box sent, the core is intended to cut through the lower end of the pattern. The pattern is not painted to represent the core as cutting through, and with the core box sent is in its present form unworkable.

Too many Core Boxes Provided.

Another weakness in patternmaking is the desire for making core boxes when considerable reduction in foundry costs could be secured if core boxes were cut out, and patterns made to leave their own cores. One quite realises that patternmakers, like other tradesmen, like to secure as much work as they can; but there is no doubt that many hundreds of pounds are wasted annually because there is not more co-operation between the foundry and the pattern shop. It may be argued in this connection that whereas dispensing with the cores would necessitate taper on patterns and other alterations, this argument cannot outweigh the great gain in cost of manufacture and the reduction of scrap where cores can be dispensed with.

Competition from Drop Forgings.

I should also like to make an observation with regard to the question of increasing taper where core making is avoided. Experience has shown that in some cases where stampings have taken the place of malleable castings, the buyer has been willing to accept stampings with a very large taper, because he cannot get them otherwise, but he would certainly refuse castings with an equivalent of "leave." Why concessions are given to stampers and drop forgers which are denied to foundries is difficult of explanation.

Reducing Coreing.

Another suggestion which might be remembered by patternmakers is the desirability of reducing the number of cores handled, by making core prints and core boxes for the purposes of coring up two or more patterns of identical shape. For instance, one pattern was intended to be used in a 20 in. x 11 in. box and to take 40 patterns. As intended by the patternmaker, two cores were necessary for each pattern. This entailed the making and placing of 80 cores per mould.

It is suggested that to work this job in a more economical way it might be handled in a small box, say of 14 in. x 11 in., which would accommodate 36 patterns. These patterns could be sprayed in sets of three. The flat core and long straight core could all be produced in one core-box, from which it will be seen that the coremaking would be reduced 66.6 per cent., or, in other words, 12 cores would core-up one mould, whereas, as submitted, 72 cores would have been required for each mould containing 36 castings. It would also be certainly quicker to make the cores in sets of three than to make six separate cores for three castings.

Another pattern which we ourselves altered in this way, with excellent results, from the saving in cost of production standpoint, was cored up, two core-prints with one core, thus avoiding the need of balancing prints, which would have taken up very useful room in the moulding box.

More Hints to Patternmakers.

There are several other minor points to which I wish the patternmaker would give attention, and one of them is the more detailed marking of patterns relative to the machining operations after the castings have been made. These markings are of considerable importance to the foundry, as will be seen. For instance, nowadays, the machining operations are cut down to a minimum, and there are many cases where merely a disc-grinding operation is performed, and this means of course that there must be no taper or leave on the surface which is to be disc-ground. But how is the foundryman to know this without the pattern being so marked, or unless he has a blue print with machining instructions before him?

Foundrymen are so accustomed to milling and planing operations where "leave" is not of much importance that they often get into trouble where castings are merely disc-ground, because this is not clearly shown on the pattern when received, and the trouble only becomes known after the castings have been delivered, and machining is started on.

A similar point might be made with regard to cored holes. Some cored holes are merely cleared by drilling or reamering, and naturally drills or

reamers follow the lead of the hole itself, and therefore the utmost care in laying the core has consequently to be taken. This is particularly difficult, as previously shown, especially when the core-print is not sufficiently taper to ensure the core centralising itself. If, on the other hand, the hole were to be machined by a boring bar, any slight variation in the position of the hole could be quickly taken up and rectified by means of the boring tool, and castings which might otherwise be scrapped could be passed through, if the nature of the operation were known to the foundry.

Marking Patterns.

It should be superfluous to plead for the proper marking of patterns, but it is a most frequent occurrence to receive patterns which bear no indication as to whom they belong, and such patterns are usually unnumbered. To illustrate the problem, we might receive, as we have within the last few days, 20 unnumbered and unnamed patterns, say motor cycle patterns, without any indication as to what the various parts are, and then in a few days someone will ring up asking how a particular part is progressing. It is quite impossible to give any information, and the inquirer thinks the foundry people are hopeless, whereas his own lack of businesslike methods are at fault.

I should like to make one plea with respect to particular patterns where the malleable foundry industry is concerned. It is common knowledge that after the castings are made—and here it is claimed that malleable castings are more difficult to make than any other—our difficulties are only just beginning. The annealing treatment often leads to warping and distortion of castings, either through defective design or packing, and this trouble might in many cases be considerably eased if webbing pieces were provided to prevent the arms or other parts of the castings offset from the main body of the casting from warping. As an example, it is found in modern design various instances where the machine shop is considered in their various difficulties, and we certainly think the time has come when some consideration should be given to the troubles of the foundryman.

Ladle Daubing.

Another feature which should be removed is the necessity for continual daubing or lining iron and steel ladles. It seems to me that it should not be beyond the skill of the various research organisations to get over this problem. The ordinary plumbago pot is too expensive for work except in connection with pot furnaces, and I therefore look forward to the time when it will be possible to line ladles with some refractory material which will stand up with some degree of permanence in contrast to the daily daubing.

Foundry Text Books.

I should also like to allude to a matter referred to by Mr. Reason in his remarks at the annual convention in Birmingham, with reference to a foundry text book, containing formulæ and general information relating to foundry work. Such a guide should be in every way equivalent to the pocket Molesworth, which is now so indispensable to the mechanical engineer. There need be no limit to the value of such a book. It should include details of mixtures for both ferrous and non-ferrous castings, and should give particulars of the various tensile strengths which such mixtures should give. It should also provide information with reference to the various melting points of different metals and combinations of metals. Admiralty and War Office specifications and tests theoretical and analytical should not be omitted. In fact, it should be so comprehensive that the foundryman may have at hand such technical information as will enable him to conduct experiments without having to cover a deal of preliminary ground which such a *vade mecum* would give.

The needs of the foundry trade in respect of the general dissemination of knowledge are perhaps more pronounced than in any industry of similar importance. Where can we find the compendium of information which will help to guide the foundryman in the selection of sand, limestone, coal dust, etc.? One is aware by way of practical experience that some sands are more suitable for some castings than others; but what is really needed is a more detailed classification of sands most suitable for casting particular classes of metal. The same remarks apply to limestone, with regard to which there seems to be very little interest displayed even by those firms and chemists that have every facility for research.

Coal Dust.

It is also surprising that coal dust, too, has not been the subject of more general discussion in foundrymen's meetings. The quality of coal dust varies enormously even when obtained from the same suppliers, and the variation causes such divergent results that here again one marvels at the general apathy appertaining to the subject.

It will be argued that I am here pleading for something which is beyond the range of practical politics at the present time, but there is no doubt that such information does exist which, if duly set forth in a foundryman's guide or such a book as has been suggested, would prove of inestimable and lasting benefit to the trade. Of course, such tests as I have hinted at need not be confined merely to the elements mentioned, but might include plumbago, parting sand, mould dressings, and the like.

In passing I might say that the Coventry Malleable Foundry has had excellent results with parting powder made of simple coal fire ash, carefully screened, and passed through a dusting bag.

Composition Tests.

Many firms, especially the smaller ones, are unable to go to the heavy expense of taking regular chemical analyses, much less support a laboratory of their own; and it would be extremely useful if such firms were in a position to take rough and ready tests of the metal tapped out. The same remarks apply to slag, which oftentimes provides a useful hint as to the silicon content. For instance, one of my predecessors has stated, if not from this table, to me personally, that green coloured slag is an indication of a safe silicon content so far as malleable iron is concerned.

Another useful indication of a silicon content is when the metal, although tapped out thoroughly hot from the cupola, suddenly becomes pasty. All such hints would be exceedingly useful if included in the foundryman's notebook.

Perhaps someone could suggest or knows of a rough and ready method of arriving at the sulphur and phosphorus content. It has been suggested that an excess of sulphur betrays itself in a scaly or pitted appearance of the runner heads, but as this suggestion has been put forward by someone interested in an anti-sulphur compound, it is desirable that confirmation should be obtained.

Might I be permitted to allude to one of the difficulties in the malleable foundry business, namely, the trouble with hardness. It is generally thought that a drilling test is the last word One Coventry machining shop has installed a device for testing the rapidity of drilling castings, yet we find that occasionally we get castings which give excellent results on a drilling test, but fail when being milled or planed. It has been suggested that an improved piece-work price for the machinists often makes the castings softer, but what we want to have is some perfect test which will remove every possible doubt as to machine qualities before castings get out to clients.

Blowpipe Examination of Refractories.—In the course of his Paper on "An Examination of Refractories by the Oxy-Hydrogen Blowpipe," read before the Ceramic Society at Birmingham, Mr. A. L. Curtis explained the appliance as being particularly well adapted for quickly examining the properties of refractories, especially for small quantities. Coal gas or acetylene could be used, but for small pieces acetylene is difficult to control. The refractory, in the form of powder, is mixed with water or with a watery solution of dextrine. The test is checked by the use of Seger-cone mixtures, similar to the refractory test pieces, and the number of seconds required is noted. A camera is used to record the changes, in conjunction with microscopic objectives, telescope objectives, etc., and the effect is watched all the time on a screen. Effects produced on several Scotch products were described. Blistering produced on test pieces of bauxitic clay was ascribed to high titanium oxide content.

What's Wrong with the Foundryman?

A few years ago the foundryman was continually "grousing." He complained bitterly that there was nothing being done to improve the status of the foundryman or his craft. Whilst then all other branches of the engineering trade were advancing rapidly by the application of education, science, and research his grumbling was quite justified, but not now.

The scientist, academician, and metallurgist are all doing their utmost to enlighten the foundryman in the fundamental principles which both underlie his craft and promote the studies of its higher branches, with the definite purpose of helping him to make less wasters and better castings by broadcasting knowledge. Instruction in foundry work in all its aspects is now available in most of the important centres, and there is a plentiful supply of foundry literature. Universities, colleges, technical institutions, etc., all open their doors to the foundryman, and the Chartered Institution of British Foundrymen exists for them. Yet, what do we find? Do we find him embracing any of these unique opportunities? No. Do we find a good attendance at any of the meetings or lectures? No. Do we find a desire in the foundryman to fit himself for the higher and more remunerative positions? No. Yet he wonders why it is when he tries to obtain one of the higher positions that he fails.

It is very distressing to see so little desire to take advantage of any of the modern practical or scientific educational movements, so little desire to improve himself, or to lift his ancient and wonderful craft out of the slough of despond. No, he seems quite satisfied to jog along with his nose in the sand all day, and to sit at home picking out the winner (?) from the sporting papers in the evening.

Small wonder, then, that we find clerks, engineers, patternmakers, non-technical men of all shades occupying positions of trust which undoubtedly ought to be filled by foundrymen

Quite recently a lecture was given by a very able metallurgist, at a great expenditure of money and time, and a more instructive and helpful lecture has seldom been delivered. Yet there were only about 40 attended, and not all foundrymen at that. Such a state of things is appalling. We may well ask, "What's wrong with the foundryman?"

Is it there are too many counter-attractions—football, betting, cinemas, billiards? Of course, all these pastimes are excellent, except betting, in their place, and very necessary to a certain extent, but when they absorb all the leisure time and thought of the foundryman to the total exclusion of all educational movements, then they are decidedly detrimental to progress.

There is, perhaps, another reason for the foundryman's lack of interest in his work, *i.e.*, apathy, and this is the worst of all, for it leads to despair. Despair leads to despondency, and this means giving up of all hope by the weakening of the intellect. Can anyone imagine a worse state for a mind into which to drift?

There will be no doubt of the result; there will be no misgivings as to the future success of the craft *if* the foundryman will only wake up; if he will make an effort; if he will make an honest endeavour to cross the road and see what the other fellow is doing. Then he will not readily leave the path of investigation and research.

The foundryman can do quite as important research work in the foundry as the academic gentleman can in the laboratory, and in a very short time these theoretical gentlemen will realise there is more in foundry work than making a hole in the sand and pouring the metal into it to secure a good sound casting.

Is it to be inferred by this apparent neglect of all educational movements by the present-day journeyman moulder that there is no hope for improvement in him? Or is it to be understood that he has reached that stage of perfection when he regards all educational movements as superfluous? If the latter, then let him remember there are hundreds of his fellow craftsmen who will regard him as a great benefactor to the craft if he will only come forward and impart some of his wonderful experience to them.

Of what use will all the extensive attainments be when he shuffles off this mortal coil? One very encouraging feature existing to-day is the attendance of so many boys and youths at the classes and lectures, eager to embrace each opportunity as it arises, and in this they must be encouraged in every possible way, so that in the next decade it shall not be asked, "What's wrong with the foundryman?"

J. E.

Iron Ore Crisis in France.

The statistics published in France at the end of August show an increase in the exports of Lorraine ore to other countries, including Germany, Belgium, and the Saar, the exports in the first half of 1922 having increased by 85 per cent. over those in the second half of 1921. Nevertheless, the future of the ore production in the East of France, according to M. A. P. in the Paris "Information," remains disquieting. The situation in the Briey district, which seems to have escaped public attention, continues to preoccupy the interested parties. Recent statistics show that the output in that district had fallen off from 15,204,000 tons in 1913 to 621,000 tons in 1919, but recovered and rose again to 3,466,000 tons in 1920. Similarly the output in the Longwy Basin declined from 2,878,000 tons in 1913 to 688,000 tons in 1919, rising to 714,000 tons in 1920. The output in the Nancy district receded from 1,897,000 tons in 1913 to 670,000 tons in 1919, and reached 816,000 tons in 1920; while the production in the Thionville district, which was 21,133,000 tons in 1913, was only 7,127,000 tons in 1919, falling further to 6,029,000 tons in 1920. Moreover, production in 1921 was equally disappointing. The gravity of the situation is further proved by the fact that the number of miners employed on both sides of the old frontier in Lorraine, which totalled 34,640 in 1913, declined to 18,826 in 1920, and further to 15,428 in 1921.

Despite the greatly reduced production the stocks of ore at the mines increased from a total of 3,042,000 tons for all districts at the end of 1920 to 3,515,000 tons at the close of 1921. In other words, it was not possible to find a market last year for a quantity representing one-fourth of the total annual output; in the Briey district alone the increase in the stocks was from 397,000 tons to 998,000 tons at the two year ends respectively. The industry in that region has been more seriously affected by the crisis than that in the other centres of ore production, and matters have gone so far as to foreshadow a possible collapse in Briey. So far these pessimistic prognostications have not been fulfilled, but the danger exists all the same. In 1921 the 18 mines in that region, which have been fully equipped at a considerable outlay of capital, were only able to show a combined output of about 4,000,000 tons, or say an average of about 220,000 tons, which is wholly insufficient to keep them going under the special conditions under which the mines in the Meurthe and Moselle are being worked.

New England Foundrymen's Association.

At the September meeting of the New England Foundrymen's Association, held at Boston, U.S.A., cupola practice was the subject under discussion. One of the features was that many foundries relied on ordinary labour to prepare charges for cupolas, and that instructions were often not adequately followed, which resulted in waster castings. The opinion was expressed that a foreman should stay upon the charging floor.

Messrs. Automatic & Electric Furnaces, Limited, have changed their address from 281-283, Gray's Inn Road, London, W.C.1, to 173-175, Farringdon Road, London, E.C.1.

The Metropolitan-Vickers Electrical Company, Limited, announce that their new season's price lists and folders are now available, and that they are prepared to overprint the name and address of any electrical contractor on a supply of this literature at his request.

Electric Furnace Operation.

By Walter Scott.

Undoubtedly the electric furnace from the metallurgical standpoint permits more homogeneity and flexibility in the application of processes and varieties of product than any other steel-making furnace yet devised; the chief characteristic being absolute control of temperature and slag conditions during the melting and finishing period. The flexibility of the electric furnace requires a thorough knowledge of essential principles on the part of the operator, because he must be able to apply any one of them. Lack of adequate knowledge of the operations involved has in many instances led to abuse of the electric furnace, whilst certain mechanical and electrical weaknesses have jeopardised the successful operation of many furnaces. However, properly made electric steel is undoubtedly superior to other grades of steel, close control of the elements ensuring a product of chemical purity with great density and good physical properties.

The installation of an electric furnace should not be carried out before a close study of economic conditions such as the cost of electricity, amount of power available, position for freights, costs of labour, etc. In operation, records should be kept of units consumed per ton of steel produced, raw materials, refractories consumed, wear and tear on moulds and other operating details. Close attention to these items should enable the electric furnace to compete favourably with the open-hearth in some classes of steels. In special steels the electric furnace will undoubtedly hold its own, and is more and more replacing the crucible process.

Furnace linings are apt to differ slightly in each works according to their practice, but the fundamental principles do not differ; in the case of a basic furnace lining ordinary firebricks, or in some cases magnesite, are used on the bottom, of course the latter being more expensive, but it has been found while minimising the risk of breakouts, magnesite is liable to cause shorting on to the furnace casting If the former they must be separated by chrome bricks. The firebricks are usually taken up to the slag line, where it is essential to have either magnesite or chrome bricks from the silica bricks which continue to the roof. In the case of a bottom-current furnace, usually a mixture of carbon paste and fine chrome is used, this being rammed over the copper conducting plates.

Difficulties are largely avoided if proper attention is given to selecting suitable dolomite, carefully heating, mixing it without using excessive amounts of de-hydrated tar. Ingredients should be carefully rammed in layer after layer, care being taken that no soft patches are overlooked, as this often leads to trouble during working. The ramming is continued until the bottom and banks are complete. In the case of an acid furnace bottom this may be formed by using peanut size ganister mixed with a little tar to bind; this should be rammed and burnt in the usual manner and fettled with sand, etc. Great care is required when bricking the roof of an electric furnace owing to the weakening effect of the electrode holes. Due allowance for expansion must be made when using silica bricks. In some cases bauxite bricks have been used with remarkable success, but allowance must be made for contraction by keying them tightly together. Pre-heating should allow for the complete burning in of the bottom, due care being taken to avoid chipping of the brickwork through neglecting the temperature. In general practice it is found that a constant low temperature is preferable, this ensuring a good burning-in without risks, allowance as to period of time required being made according to the size of the furnace.

Furnace Operation.

Most kinds of scrap can be used, but if possible only the best should be employed, as this will be found more economical in the long run by not retarding the working, as is usually the case when using dirty scrap which causes undue accumulations of slag, loss of metal, and over-oxidised metal. It is usual to charge 25 per cent. of closely packing scrap in the form of shearings, punchings, or heavy turnings; also it will be found more economical when charging to distribute the light turnings round the lining, this serving to protect it during the melting period. Lime, and, if necessary, a little ore, is charged in with the scrap. After melting, and assuming that the analysis is correct and the metal sufficiently hot, the slagging operations are begun, which entails the entire removal of the oxidising slag.

This operation entails two distinct operations: —(1) Oxidation of the elements silicon, manganese, carbon, and phosphorus. (2) After making the second slag, the reduction of sulphur and any oxides left from the preceding operation. After slagging, the necessary amount of carbon is added either in the form of anthracite or coal dust, which is readily taken up by the metal. It is usual to add a little ferro-silicon, fluor-spar, lime, etc., to form the necessary reducing slag. The current is again switched on at a lower voltage, and preparations made to get the slag fluxed into proper condition for de-oxidising and de-sulphurising the metal; this condition is only obtained by careful observation of the temperature and slag conditions. It is essential that a good thick fluid slag is maintained by adding lime and fine carbon; if the slag should thicken up, a little spar will be found to be beneficial. Modern practice in killing the metal is to use the least possible amount of silicon; this is only possible if the correct temperature is maintained; nothing causes wild metal more than erratic temperatures, which disturb the slag conditions. Prior to tapping, the necessary alloys, if any, are added.

Typical Melting and Finishing Slags of a 7-ton Heroult Furnace.

Cast No.	Slag sample.	SiO_2.	FeO.	Fe_2O_3	CaO.	MgO	MnO.	P_2O_5.	S.
1	Melting	9.40	21.02	8.80	38.80	10.52	3.55	1.65	0.42
1	Tapping	30.40	0.68	—	64.00	3.07	0.22	—	0.42
2	Melting	11.70	23.04	8.00	37.40	6.99	4.70	2.41	—
2	Tapping	21.60	2.04	—	64.60	3.87	1.20	—	0.10
3	Melting	10.50	19.58	6.40	44.40	8.00	4.00	2.75	—
3	Tapping	11.40	—	—	—	—	—	—	0.27
4	Melting	13.20	13.00	5.20	48.10	7.29	4.30	1.39	—
4	Tapping	9.60	1.01	—	66.20	3.00	1.48	—	0.91
5	Melting	10.20	21.31	9.60	41.60	6.70	3.16	2.32	—
5	Tapping	13.30	1.57	—	63.00	—	1.30	—	0.80

The melting slags as referred to in the table were taken just before slagging, whilst the tapping slags were obtained just before tapping. It will be noticed that a few of the tapping slags are low in SiO_2. In these particular casts a little calcium-carbide was used to help the slag, and was found most beneficial; it appears to have a retarding effect on the loss of silicon, and in each cast it was found that the theoretical addition was more or less retained in the steel.

Swedish Iron and Steel.—The subjoined table shows the Swedish imports and exports of iron and steel, and the exports of iron ore, during August, 1922, and the eight months January-August, 1922, compared with the same periods in 1921:—

	Aug., 1921.	Aug., 1922.	Jan.-Aug., 1921.	Jan.-Aug., 1922.
Iron and steel:	Tons.	Tons.	Tons.	Tons.
Imports ..	8,770	13,083	98,648	77,324
Exports ..	9,749	15,393	77,761	100,556
Iron ore:				
Exports ..	395,525	605,555	2,956,054	3,216,197

The June figures were given in our issue for September 1.

The Selling Price of Grey Iron Castings.

By H. E. Burrell.

Many foundries have on their books one or a few customers who purchase their castings at an all-round price per cwt. These customers are either large concerns in textile and such industries who possess an engineering department for the repair and maintenance of their plant; and who are continually requiring machinery castings, or engineering firms whose producing capacity is not sufficiently large to efficiently run a foundry of their own.

An all-round price per cwt. is usually agreed upon after consideration of the varieties and weights of castings required, and so long as these are proportionately maintained, the price is fair to both parties.

In the former case, the one who purchases castings for the maintenance of his plant, it will be found that the class of work continually required is as expected, and therefore the price arranged proves satisfactory. But with regard to the latter type of customer, this is rarely so. The castings required eventually take the form or enter into a product which he mauufactures to sell, and which has to face competition. The competition proceeds from both large and small establishments. The larger establishments will possess foundries of their own, and obviously will have some method of grading the prices of their castings according to cost. The all-round price per cwt. may be the same with all the competitors, but the larger establishments in all probability manufacture other classes of products, and therefore find it necessary to obtain detailed costs.

The customer who buys at an all-round price naturally bases his material costs on this figure. He knows as well as the founndryman that some castings cost far more and others much less both as regards variety and size, but he has no cost records to work on, and therefore does not take the risk of grading.

High Cost Work at Average Price.

The result is, assuming his manufacturing conditions to be equal to those of his competitors, that the customer will obtain a class of work, the castings for which cost a high rate to mould, as he has based the material price of his product on the all-round price he pays. The competitor with a foundry of his own, and who grades his prices in accordance with cost, will include approximately correct material costs in arriving at his selling prices. These selling prices will, in some cases, be higher, and in others lower than the customer, according to the price-grade of castings entering into the product, and it can therefore be easily seen what class of work the customer is going to obtain. It will be work for which his price is favourable, which means where the foundry is concerned, work which has a high moulding cost. The other kind of work, "good heavy plaiu stuff," as the foundryman would say, never comes the way of the customer, for it enters into his selling price at the all-round figure he pays the founder, and not at the figure it actually costs, which is lower. All that class of work which would be very acceptable goes to the competitor who grades according to cost.

Such a position does not affect the customer very much.

He continues to receive orders of a certain kind and is making his customary profit. But the castings he is calling for from the foundry will be of the higher-price grade, and he will be obtaining them at the all-round price fixed at an earlier period, which of course means that the foundry is losing money on the business, and very probably will continue to do so for quite a long period. For when an agreed all-round price is once arranged, there does not appear to be any reason for alteration excepting in accordance with the fluctuation in costs of raw material and labour.

Where the foundry is a small one, and a customer of this nature taking a large percentage of the output, the financial condition of affairs will rapidly become worse, and a thorough investigation will find that the castings being made are not of the variety and weight which was expected when the fixed price per cwt. was agreed upon.

Where the foundry is a comparatively large one, and the customer taking only a small percentage of the output, the financial deterioration will be yet as sure, but more gradual, and will continue until sufficiently alarming to necessitate a thorough investigation, with the same result as stated above.

All-Round Price Fundamentally Wrong.

When the all-round price is agreed upon, the customer, in all good faith, fully expects to purchase all the varieties upon which the price is based, but this all-round price, being fundamentally wrong, defeats such expectation, particularly so during lean times when competition is keen.

Foundries, like other sections of the engineering industry, have during recent years more fully realised the great variation possible in the cost of various products, and the absolute necessity for methods of cost finding for fixing selling prices, castings being graded on a broad basis of the relation of the time occupied in moulding to the actual weight of the casting.

All-round prices to customers with a variety of requirements which enter into or form varied saleable products, is not a paying proposition for the founder. If at all possible, he should grade his selling prices according to costs, and if he considers this impracticable, should take particular care to see that the varieties and sizes of castings continually demanded are as expected at the time the agreed all-round price was made.

Contracts Open.

Dublin, October 23.—Supply of switches, for the Great Northern Railway (Ireland) Company. Mr. J. B. Stephens, secretary, Amiens Street Station, Dublin.

Edinburgh, October 20.—Supply of general stores required in the Gas Department for six months, from November 16, 1922, for the Town Council. Mr. H. H. Gracie, engineer and manager, 15, Calton Hill, Edinburgh.

Melbourne, January 15-31.—Supply, delivery, etc., of the following for the Morwell power scheme, for the State Electricity Commission of Victoria. Specification No. 308.—Back pressure steam turbine, including one 1,500-kw. turbo-alternator with exhaust valves, exhaust pressure regulator, etc. No. 317.—Water-tube boilers and accessories, including Section 1—Four boilers 4,500 sq. ft. h.s., step grates, dampers, mountings, etc. 2.—Structural steelwork for boiler-house, bunkers and turbine-house, including floor framing, stairs, etc. 3.—Turbine-driven feed pumps, make-up pumps, collector drums, tanks, meters, etc. 4.—Complete system of piping, valves, etc., for all plant. Agent-General for Victoria, Melbourne Place, Strand, London, W.C.2. (Fee, £2 2s., returnable.)

Newcastle-upon-Tyne, October 28.—For the construction and delivery of one non-propelled centre ladder barge-loading bucket dredger, four single-screw steel steam hopper barges, each with a hopper capacity of 800 tons, for the Tyne Improvement Commissioners. Mr. J. MacDonald Manson, general manager and secretary, Bewick Street, Newcastle-upon-Tyne. (Fee, £5 5s., returnable.)

Cerium as a Steel Alloy.—The study of cerium as an alloying element in steel, conducted at the Ithaca, N.Y., station of the U.S. Bureau of Mines, in co-operation with the Welsbach Company, has been finished. The attempt to utilise the cerium group of metals, made from by-products of the gas-mantle industry, in alloys other than the pyrophoric alloys, gave only negative results. In aluminium alloys the cerium group of metals had no useful effect either as alloy materials or as scavengers. In steel the desulphurisation effected by the cerium metals was accompanied by the retention in the steel of inclusions due to the cerium metals. The harmful effect of the inclusions over-balanced any good effect due to desulphurisation or to the presence of cerium metals as alloying elements. Either plain carbon steel, or various alloy steels to which cerium was added, were not improved; usually, especially when heat-treated, they were decidedly poorer than similar steels without cerium. Collected data showed cerium to have no marked effect as a true alloying element in steel, and to be harmful rather than helpful when used as a scavenger. The conclusion drawn was that, under any condition tried, the cerium group of metals was not useful either in steel or in aluminium, and such data as were available indicated that it would not be useful in other non-ferrous alloys.

The Nitrogenisation of Iron and Steel by Sodium Nitrate.*

By L. E. Benson, B.Sc. (Manchester University).

During some experimental work specimens of Armco iron and steels of varying composition were annealed in a salt-bath at a temperature of 500 deg. C. for varying lengths of time, having been previously normalised from 950 deg. C. Subsequent microscopical examination showed that most of the specimens so treated had developed a structure within the ferrite grains similar to that generally associated with the presence of nitrogen.

Although the specimens whilst in the salt-bath stood on a porcelain plate, their carburisation by diffusion of carbon from the cast-iron container, or from carbonaceous impurity in the salt, appeared to afford a possible explanation of the structure, as at that temperature (500 deg. C.) any carbide formed would precipitate along the cleavage planes and crystal boundaries. In order to explore this possibility, a specimen of the normalised Armco iron was annealed for 2½ hours at the same temperature in a bath of recrystallised sodium nitrate contained in a porcelain crucible. As a result of this treatment the iron was found to have developed the nitride structure to an average depth of 0.2 mm. from the surface.

A sample of Armco iron before annealing was found to contain less than 0.002 per cent. nitrogen. A specimen annealed for ten hours was observed under the microscope to exhibit the nitride structure to an average depth of 0.4 mm. Approximately 1.5 mm. was filed off all the faces of this specimen and the filings collected. A further 1 mm. was then filed off. The nitrogen content of the three samples was found to be as follows:—Outer layer, 0.036 per cent. nitrogen; intermediate layer, 0.004 per cent. nitrogen; core, 0.002 per cent. nitrogen. From these determinations it would appear that the specimens in question had become nitrogenised through being annealed at a temperature of 500 deg. C. in a salt-bath containing sodium nitrate.

As sodium nitrate is frequently the chief constituent of salt-baths for low-temperature heat treatment, it was thought advisable to investigate how far nitrogenisation was likely to affect iron and steels under varying conditions. The influence of time on the rate of penetration of nitrogen in Armco iron has been investigated up to eighty hours, and in various steels up to twenty hours. In general, the penetration was observed to be very uniform, and only in a very few cases was any difficulty experienced in arriving at a fair estimate of the average depth. The results of the penetration measurements will be found in Table I. The rate of penetration of nitrogen in steel in general appears to be considerably slower than in pure iron. It is seriously influenced by the presence of carbon, the rate being lowered as the carbon content rises.

Table I.—*Penetration of Nitrogen in Millimetres.*

Time of annealing.	A.	B.	C.	D.	E.	F.
Normalised	0.00	0.00	0.00	0.00	0.00	0.00
1 hour ..	0.15	0.00	0.05	0.00	0.00	0.00
5 hours ..	0.30	0.20	0.20	0.15	0.15	very slight
10 ,, ..	0.40	0.30	0.25	0.20	0.20	
20 ,, ..	0.70	0.40	0.30	0.20	0.20	
80 ,, ..	2.00	—	—	—	—	

A=Armco iron (guaranteed purity 99.84 per cent.).
B=Pure carbon.
C and D=Crucible steels.
E=Open-hearth steel.
F=Acid-Bessemer steel.

That the presence of pearlitic areas in the ferrite should impede the diffusion of nitride seems only natural, but the retardation produced by only 0.16 per cent. carbon as compared with that produced by 0.37 and 0.58 per cent. carbon seems sufficiently great to suggest that possibly influences other than merely the presence of pearlitic areas have contributed, and a greater solubility of carbide in alpha iron than has generally been supposed to exist might be expected to affect the rate of penetration thus.

Manganese would appear to exert a more profound influence on the rate of penetration than does carbon. This is in accordance with Tschischewski's observations on the nitrogenisation of iron manganese alloys.

The curve for steel containing 0.4 per cent. carbon and 0.54 per cent. manganese is identical with that for pure 0.6 per cent. carbon steel, but in the case of the acid-Bessemer steel containing 0.89 per cent. manganese the penetration was very slight indeed. Even after twenty hours' annealing the nitride structure was only observable in the outermost layers.

Tschischewski has found that above 450 deg. C. nitride of iron is unstable, and in this connection it is of interest that a piece of Armco iron 0.5 cm. thick, nitrogenised to such an extent that the characteristic needles could be observed almost to the centre of the mass, after heating in an open muffle for 90 minutes at approximately 700 deg. C., showed no signs at all of nitride structure, and on analysis the nitrogen content was found to be only 0.0025 per cent.

* Abstract from a paper read before the Iron and Steel Institute at the autumn meeting at York.

Research for Metals Industry.

An interesting pamphlet, "Research Work in Progress," has just been issued by the British Non-Ferrous Metals Research Association of 71, Temple Row, Birmingham. The investigations in hand cover many important problems of the copper, brass, aluminium, nickel and lead industries, as well as subjects of importance to all users of such metals. The support given to this Association by the leading firms seems to be most encouraging, but the field covered is very wide, and many of these researches such as those on the improvement of brass, on metal polishing, and on soldering should attract the attention and support of many other sections of industry. Of particular interest to foundrymen is a research which is being conducted on the surface and internal soundness of ingots, by Dr. H. Moore and Mr. R. Genders, B.Met., at the Woolwich Research Department. The user is apt at first sight to overlook the fact that he is even more interested in the improvement of quality of his raw material than the manufacturer of the metal. In the case of failure, however, it is the user who always bears the greater loss, since he sacrifices all the time and workmanship which has been expended on the article being manufactured.

The Bureau of Information of the Association also seems to be doing excellent service in distributing to members reports of the results of the experimental researches and acting as a live intelligence service collecting and distributing information likely to be of service to the industry from the far corners of the world.

Finally some indication is given of the further work which the Council hope to take up when additional financial support is forthcoming, which includes problems of importance to the electrical industries, to die casters and to the tinplate trade.

Waste in the Metal Industry.—Mr. A. J. Smout, the newly-elected president of the Birmingham Metallurgical Society, in the course of a presidential address devoted to the subject of "Waste and Inefficiency in the Metal Industry," said that a great deal of waste was caused by insufficient training, the industry having suffered from the lack of individual attention formerly given to youth and apprentices. Probably the greatest need of the metal industry was first-class technically-trained men to occupy the various positions of plant control coming between the directorate and manager and the manual worker. The Engineering Society's Committee of America found that in 15 representative plants 80 per cent. of the responsibility for waste rested with the managers and executives in control of the plant. One of the best methods of discovering waste was to adopt a modern cost system. Losses in ore dressing and concentration prior to smelting were often startling, and while the use of flotation processes had effected saving, there was still much to be done. On the question of fuel waste the speaker justified the emission of a certain amount of black smoke from chimneys, and considered that this form of waste had been greatly exaggerated. There was great scope, however, for the use of briquettes, which were very commonly employed in Germany, thereby saving coal which otherwise would be unfit for use. An enormous quantity of fuel could be saved by the collection of pit waste from the picking belts and gravity washers used at the collieries.

Trade Talk.

Bamlett's Agricultural Engineering Works, Thirsk, restarted last week.

Clyde & Company, Limited, merchants and engineers, have removed to 61, Fore Street, London, E.C.2.

The Chemical and Metallurgical Corporation, Limited, have purchased a site in West Ham for the erection of works.

It is stated that Sir William B. Peat has been appointed receiver and manager on behalf of the debenture holders of Sheffield Steel Products, Limited.

Brook, Hirst and Company, Limited, Northgate Electrical Works, Chester, have appointed T. Hood and Company, Limited, 7, St. Stephen's Avenue, Bristol, as their agents in the West of England.

The works of the Welsh Metals Extraction Company, Limited, are now to be sold by auction, as it has been found impossible to make arrangements to pay off the bank.

The Asiatic Steam Navigation Company have placed orders with Charles Connell & Company, Limited, Scotstown, for two steamers of 8,500 tons dead weight each.

John Blair & Company, 80, Coleman Street, E.C., have been appointed sole London agents for the Dorrator Iron Company, Limited, Camelon, Falkirk, for the sale of rain water pipes and connections.

Metropolitan-Vickers Electrical Company, Limited, have taken the order for the electrical equipment for the rolling stock for the new Piccadilly line. The value of the order is approximately £160,000.

The importance of eliminating waste and inefficiency in the metal industries was the subject brought before the members of the Birmingham Metallurgical Society by Mr. A. J. G. Smout on his inauguration as president on October 4.

Mr. J. E. Fletcher delivered a lecture on "Working Slags in Ferrous Processes," before the members of the Birmingham Metallurgical Society at the Chamber of Commerce Buildings, New Street, Birmingham, on Wednesday.

W. Canning & Company, Limited, Great Hampton Street, Birmingham, have established a warehouse at 7 and 9, Sycamore Street, Sheffield, where stocks of machinery and equipment for electro-plating, polishing, lacquering, and bronzing will be carried.

Mr. W. R. Richardson, of Sir W. G. Armstrong, Whitworth & Company, Limited, recently read a paper on "Steel" before the Newcastle and District Association of Foremen Engineers and Draughtsmen. Mr. J. G. Brewster presided.

Mr. D. Brostrom, shipowner, of Gothenburg, has placed an order with the Deutsche Werft, of Hamburg, for the construction of two Diesel-engined vessels having a cargo-carrying capacity of 20,600 tons each. The vessels are for the transport of ore from Chile to New York for the Bethlehem Steel Company.

The Works Committee of the Mersey Docks and Harbour Board has recommended acceptance of the offer of Cammell Laird & Company, Limited, of Birkenhead, to construct two self-propelling steam hopper barges, each having a carrying capacity of 1,000 tons, and 205 ft. in length, with a loaded draught of 14 ft. and a speed of 11 knots.

John Bedford & Sons, Limited, Lion Works, Sheffield, announce the retirement of their London agent, Mr. T. E. Dickinson. In future the London agency will be controlled by C. Phillips, Jones & Company, at 6, Lloyd's Avenue, E.C.3, under the supervision of Mr. John Bedford, a director of the company.

The adjourned conference of the engineering and shipbuilding employers and employed was held in Edinburgh last week for the purpose of receiving the report of the situation as revealed by the ballot. The figures were as follow:—For acceptance of employers' proposals, 7,148; for resisting by a strike, 24,267; for further negotiation, 57,824.

The ascertainment for September shows that the selling price of West Coast hematite mixed numbers was £4 9s. 5d. per ton, a reduction of 1s. 10d. per ton compared with the previous month, and of 16s. 5d. per ton compared with the price in January of this year. As the sliding scale is in abeyance pending the completion of the negotiations between the Ironmasters' Association and the Blastfurnacemen's Union, the percentage on the base wage cannot be stated.

The ascertainment issued by the Cleveland Ironmasters' Association certifies that the average net selling price of No. 3 Cleveland pig-iron for the past quarter was 85s. 7.16d. per ton, a reduction of 2s. 4.48d. per ton, as compared with the price for the previous quarter. Under the sliding scale arrangement there will be a reduction in blast-furnacemen's wages of 2.25 per cent., which will bring the wages from 26.25 per cent. to 24 per cent. above the standard. The reduction takes effect from October 1.

An award has been issued by the Industrial Court in regard to foundry labourers at Dowlais, giving certain base rates to the workers concerned in lieu of those at present in force. The parties to the case were the Workers' Union and Guest, Keen & Nettlefolds, Limited. This decision is supplementary to Decision 736, which dealt with a claim by the Union to the reinstatement of a quarter turn per shift, previously paid at the ingot mould foundry, Dowlais Works. In that decision the Court found that the payment of the quarter turn should not have been discontinued without notification, and they reinstated the quarter turn for a limited period in order to give the parties opportunity of discussing whether, on the merits of the case, the men concerned were entitled, by reason of the character of their work, to some payment over and above that of the ordinary labourers. The parties were directed to take this matter into consideration, and to determine the amount of the difference, if any, of the two rates in the light of the practice of other works employing a similar class of men. The parties were unable to agree, and the matter reverted to the Court, who accordingly sat to hear evidence on September 28. The further evidence submitted satisfied the Court that in so far as the extra payment rested upon considerations of output, the reason for its payment had disappeared. They were also satisfied, however, that the extra payment did not rest solely upon this ground, but that other circumstances were taken into account. It was right, therefore, that part of the extra payment should now disappear and that part should remain. As regards the part that should continue to be payable, the Court were of the view that they should be guided by the rates paid to men doing similar work at the only other ingot-mould foundry in the district. They accordingly decided that in lieu of the present base rates there shall be paid base rates as follows:—Cupola-man, 5s. 7d.; assistant, 4s. 11d.; ladleman, 4s. 11d.; labourer—tempering sand, 4s. 11d.; chipper, 4s. 11d.; labourers, 4s. 10d.

Catalogues Received.

Messrs. Pratchitt Brothers, engineers, Carlisle.—The section dealing with sand mills will be of interest to foundrymen.

Messrs. Sefco, Limited, Gipping Works, Stowmarket.—This little book outlines the advantages of Sefco—a new iron cement—as a filling for blowholes, cracks, and for smoothing rough places on castings.

Reversible Expansion of Silica.—At the recent Birmingham meeting of the Refractory Materials Section of the Ceramic Society, Mr. H. J. Houldsworth and Professor J. W. Cobb replied to more criticism by Dr. Fenner on the results set forth in their Paper on "The Reversible Thermal Expansion of Silica," read by them before the Section at a previous meeting. Dr. Fenner, in his criticism, contended that the results obtained by Messrs. Houldsworth and Cobb, far from being contradictory of anything he had obtained, were really a repetition in all essential respects of his own results. The only difference was that the presence of a little soda seemed to have effected the transformation to cristobalite at a somewhat lower temperature. Emphasis was laid on two important points: (1) The transformations of silica were of a very sluggish character, and (2) an unstable form often took the next less unstable form before changing into the stable form. Circumstances might thus delay indefinitely the conversion into the stable form. In any case, on reheating the material for a few hours (at the given temperature) after addition of a little sodium tungstate, very definite evidence of the production of the stable form would ordinarily be obtained. In reply, Mr. Houldsworth and Prof. Cobb pointed out that the primary object of their work was the determination of data concerning the reversible thermal expansion of different silica products after varying heat treatments, for approximately the ranges of temperature, time, composition, etc., occurring in practice. They looked on Dr. Fenner's original Paper on "The Stability Relations of Silica Materials" as an extremely valuable contribution to the study of silica inversions, but in most of his experiments he heated silica with large amounts of sodium tungstate, and for their purpose it was necessary that silica material should be examined without that flux.

Company News.

Maximon, Limited.—Capital £20,000 in £1 shares. Engineers.

Anderston Foundry, Limited.—Interim dividend, 3s. per share, less tax.

Mountstuart Dry Docks & Shearmans, Limited.—Balance-sheet deferred.

Bussey & Sabberton Brothers, Limited.—Capital £15,000 in £1 shares. Engineers.

Richardsons, Westgarth & Company, Limited.—Interim preference dividend, 3 per cent.

Stanton Ironworks Company, Limited.—Half-year's preference dividend, 6 per cent. per annum.

Clayton & Shuttleworth, Limited.—No interim dividend on 5 per cent. cumulative preference shares.

Yates & Thom, Limited.—Dividend, 7½ per cent. actual for year; reserve, £10,000; carried forward, £15,007.

C. A. Daniel, Limited, Aston Brook Street, Birmingham.—Capital £500 in £1 shares. Pattern makers, founders, etc.

Furness, Withy & Company, Limited.—Ordinary dividend, 5 per cent. per annum for half-year; preference dividend, 5 per cent. for half-year.

Thomas Smith's Stamping Works, Limited.—Profit, £17,050; brought forward, £13,085; dividend, 7½ per cent., less tax, for year; carry forward, £16,697.

Tinsley Rolling Mills Company, Limited.—Accounts show loss £8,658; no dividend on ordinary; brought forward, £12,098; credit at profit and loss, £3,437.

R. W. Barker & Company, Limited, Oakwood Parade, 450, Roundhay Road, Leeds.—Capital £2,000. Engineers, etc. Directors: H. A. H. Walker, S. Verity, and R. W. Barker.

Delta Steel Company (Sheffield), Limited.—Capital £3,000 in £1 shares. Permanent directors: H. M. Hurst (managing director), G. W. Hurst, and C. E. Moore. Secretary: W. Neal.

L. P. M. Syndicate, Limited, 82, Victoria Street, Westminster, London, S.W.—Capital £15,000 in 12,000 10 per cent. cumulative preference shares of £1 and £60,000 deferred shares of 1s. Engineers.

John Fowler (Don Foundry), Limited, Don Foundry, Attercliffe, Sheffield.—Capital £22,000, in £1 shares, to acquire the business of an ironfounder carried on by J. Fowler. Directors: J. Fowler (permanent director and chairman), C. C. Marshall, J. K. Smith and F. Betts. Secretary: F. Laister.

Gazette.

Palmer Foundry Company, Limited, London, S.W.—Mr. G. W. Roberts, 2, Guildhall Chambers, 31/4, Basinghall Street, E.C., I.A., was appointed receiver, September 21.

Messrs. T. Young and G. H. Burgess, consulting and inspecting engineers, 39A, New Street, Birmingham, trading under the style of Young & Burgess, have dissolved partnership.

Messrs. B. N. Taylor and F. C. Hayter, engineers' manufacturers, Park Street, near St. Albans, and Edgware, trading under the style of Taylor & Hayter, have dissolved partnership.

Stirlingshire Iron and Stove Company, Limited.—It has been resolved: That the company be wound up voluntarily. Mr. R. Macfarlan, 149, West George Street, Glasgow, C.A., was appointed liquidator.

Messrs. S. S. Jackson and H. J. Jackson, engineers and wheelwrights, Great Baddow, trading under the style of S. & H. Jackson, have dissolved partnership. Mr. H. J. Jackson will continue the business in his own name.

Messrs. W. R. Barrett, D. George, and D. E. Morris, metal merchants, etc., Swansea and Rouen, have dissolved partnership. The business will be continued under the same name by Messrs. W. R. Barrett and D. George.

Messrs. A. C. Powell and W. Crossley, engineers, Carr Mills, Meanwood Road, Leeds, trading under the style of Powell & Crossley, have dissolved partnership. Mr. A. C. Powell will carry on the business on his own account.

Bevan & Company (Iron and Brass Founders), Limited, Neath.—It has been resolved and confirmed: That in order to carry into effect the agreement, dated August 18, 1922, between T. J. Bevan, on behalf of Bevan & Company (Iron and Brass Founders), Limited, and Wm. E. Cope, Glentworth, Sketty, Swansea, for sale of the undertaking of this company to said W. E. Cope, in accordance with resolution passed by a directors' meeting of this company on November 3, 1921, this company be wound up voluntarily. Mr. F. Jennings, 14, Green Street, Neath, I.A., has been appointed liquidator.

Personal.

The late Mr. Charles Keay, engineer, of Cromwell House, Oakfield Road, Selly Park, left gross estate of the value of £53,493, with net personalty £45,643.

Mr. H. Douglas, assistant manager of John Tullis & Son, Limited, St. Ann's Works, Bridgeton, Glasgow, has been the recipient of presentations from the directors, officials, and employés of the company to mark his completion of fifty years' service.

Mr. W. B. M. Jackson, of the Sheepbridge Coal and Iron Company, Limited, has, owing to pressure of business, resigned his membership of the Chesterfield and District Employment Committee. The company have been invited to nominate another representative.

Mr. J. Jenkins, chief engineer to the Glasgow Iron & Steel Company, Limited, Wishaw, who has been appointed to the post of chief engineer at Messrs. Guest, Keen & Nettlefold's Dowlais Works, has been the recipient of a presentation from the staff and employés at the Wishaw works.

Mr. J. P. Anderson has been appointed assistant engineering manager to Cammell, Laird & Company, Limited, Birkenhead, taking the position left vacant when Mr. W. H. McMenemey was made engineering manager some months ago. Mr. Anderson was formerly chief draughtsman at the engine works of Workman, Clark & Company, Limited, Belfast.

Mr. Leonard Ropner, of the Ropner Shipbuilding and Repairing Company (Stockton), Limited, has been elected president of the Shipbuilding Employers' Federation in place of Mr. James Lithgow, of Lithgow, Limited, Port Glasgow, who retires. Mr. Grant Bartley, Dundee, becomes senior vice-president, and Mr. John Barr, managing director of Vickers, Limited, Barrow, has been elected junior vice-president.

Deaths.

Mr. Isaac Johnston, secretary of Messrs. Harland & Wolff's Govan Works, died suddenly at Banff, Scotland, last week.

Mr. P. St. John Dawnay, of Penylan Road, Cardiff, the youngest and only surviving son of the late Sir Archibald Dawnay, of Archibald D. Dawnay and Sons, Limited, constructional engineers, London and Cardiff, died recently at the age of forty-eight.

Mr. H. Huse Campbell, superintendent and general manager of the Pennsylvania Steel Company, at Steelton, Pa., U.S.A., has died at the age of 63. Mr. Campbell will be remembered as the author of the well-known work, "The Manufacture and Properties of Steel."

Mr. Samuel Withers, for many years a prominent figure in the public and commercial life of West Bromwich and district, died recently. Mr. Withers, who was in his 82nd year, founded the firm of Samuel Withers & Company, Limited, which has grown to be one of the largest safe manufacturing concerns in the country.

Mr. Marmaduke Wardlow, who died on October 5, was one of the most prominent business men in Sheffield, and last year filled the position of Master Cutler. Mr. Wardlow had been in failing health for some time, and there is little doubt his devotion to business and to the high office which he held contributed to the final breakdown. Mr. Wardlow was a prominent figure in the steel world of Sheffield, being the proprietor of the firm of S. & C. Wardlow, of Portobello Steel Works, Sheffield, and Congress Works, Oughtibridge. He was the only son of Mr. Charles Wardlow, Senr., who, with his brother Samuel, founded the firm in 1883. Mr. Marmaduke Wardlow, when 21 years of age, entered the firm as partner with his cousin, Mr. Charles Wardlow, and when the latter retired from the firm in 1892, Mr. Marmaduke Wardlow became the sole proprietor.

More Foundry Papers.

In common with most other engineering societies, the Manchester Association of Engineers are interesting themselves in foundry practice. This session they are having two papers on the subject. The first is on November 24, when Mr. W. H. Cook deals with "Plate Moulding," and the second on March 9 when Mr. E. Adamson lectures on "Carbon in Cast Iron."

Mr. David McLain, who sailed last Saturday on the *Tuscania* for New York, was offered a farewell dinner by Prof. Campion and Messrs. Matt. Riddell, J. Cameron, Donald King, James Shanks, G. A. Ure, J. T. Moore, and others. He hopes to revisit Great Britain in the spring.

IRON AND STEEL MARKETS.

Pig-iron.

Although production of pig-iron continues on its previously restricted scale, the tone of markets remains consistently firm, and with stocks in makers' yards almost depleted, values are distinctly stronger. The chief factor in the position is, of course, the American demand, which, although labour troubles on that side are fast disappearing, is due to the prolonged suspension of pig production during the strike period, and a consequent scarcity of raw material for current manufacturing requirements. These conditions have naturally favoured home producers, this month's shipments of pig-iron to Atlantic ports for the first ten days amounting to nearly 15,000 tons from Tees-side alone, while heavy tonnages have also been despatched from the Clyde. In the Midlands very little advantage has accrued to pig-iron producers from the increased demand for export, and here, also, makers are heavily handicapped by the advance in coke prices, which unquestionably retards any substantial revival of home consumption. The finished iron manufacturers are, however, taking a little more tonnage than of late, but unfortunately the foundry branch still remains quiet, not having yet fully recovered from the effects of the engineering stoppage. There has been no material change in the Cleveland market, wherein, though the volume of business is somewhat reduced, American demand is still the outstanding feature. Signs of improvement are also perceptible in the home trade, subject, however, to some competition from Midland and Continental iron especially affecting buying on Scottish account. Tees-side makers have also to complain of the steady increase in fuel costs, furnace coke having advanced by something like 4s. 6d. per ton, which means about 6s. on every ton of pig-iron. Consequently there can be little hope of any reduction in pig-iron prices so long as coke continues so dear; on the contrary, the tendency is much more likely to be in the other direction. Up to the present Cleveland makers have made no move, but quotations are all very firmly held. Stocks of the better qualities, too, are very scarce. Still, the position is a very uncertain one, for as soon as American buyers are off the market the effect of the current high prices will be keenly felt. The following are current quotations:—No. 1 and silicious, 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s. per ton.

In contrast with what was expected, the market for East Coast hematite has made a striking recovery, the relative cheapness of this material as compared with foundry iron having attracted the attention of American buyers, with the result that substantial tonnages have been disposed of. Home consumers are also ordering more freely, and in consequence the heavy stocks held a short time back have very nearly disappeared. As a result quotations have sharply advanced, and at last week's Tees-side market 91s. was a minimum figure for mixed numbers, most makers, in fact, standing out for 92s. to 92s. 6d. per ton. The No. 1 quality is at a premium of 6d. to 1s. per ton. Only a month ago it was possible to buy mixed numbers at as low as 88s. per ton, and makers will still have a lot of cheap iron to get off their books. The better conditions in the steel trade and in shipbuilding point to a maintenance of the recent improvement, while the rise in coke prices will effectually prevent any early return to the recent very low levels. West Coast hematite prices are unchanged, Bessemer mixed numbers being quoted at 100s. per ton delivered at Glasgow and Sheffield, and for export at 102s. 6d. to 105s. per ton.

Finished Iron.

As usual, there was a large attendance at the quarterly meeting last week, visitors being present from all the principal centres of the industry. In every department demand was much below what is required to give business even a semblance of activity and prosperity. In view of the present state of the markets buyers were not prepared to enter into forward contracts of any size; indeed, their purchases were mainly of the hand-to-mouth order. The limited volume of business negotiated was chiefly restricted to the bar-iron section, in which marked qualities alone continue steady and firm at the previous quotation, £13 10s. Good quality crown bars can now be bought below £11, while nut and bolt iron, under the pressure of foreign competition, has now fallen to £9 15s.; in addition to this the home demand is rather quiet. Gas strip does not make any headway against steel strip, which can be bought for much less, and the makers have had a meeting with the object of avoiding competition, the £11 price having been cut recently.

Steel.

Some degree of returning confidence is expressed of late in the prospects of the steel trade by a resumption of partial activity in employment, the returns for Sheffield and district showing a gradual absorption of workers, while a rather better volume of inquiries on export account is another feature indicating improvement in business. In the latter connection some fair orders having been booked from the Colonies and Russia. In the market for semi-products some scarcity of basic billets is reported, but acid qualities are fairly plentiful. For hard basic billets the quotation is £8 5s., for medium £8, and for soft £7 5s., delivered Sheffield. For Bessemer acid billets the figure stands at £12 10s., and for Siemens acid £10. Quite a proportion of the business in basic billets is for export. The Welsh makers have reduced their price for sheet and tinplate bars to £7. Steel manufacturers state that the call for special steels is decidedly better, while the improved demand for stainless is such that several additional electric furnaces have been put into operation. For steel strip there is a remarkably good demand just now, this applying to both hot and cold rolled, with spring steel another active item. The ferro-alloys market also evidences movements favourable to a further expansion of the steel trade, ferro-silicon, for example, showing a better demand, with similar indications applying in the case of high-carbon grade ferro-chromes, 4/6 per cent. having been called for in several directions, both for home consumption as well as for export. This in itself may be taken as a sign of the times, and suggests that the heavy trades and large industrial concerns are getting more substantial orders for their productions. The tinplate market of late has shown a more active tendency, and a more confident tone is now apparent. South America is still buying, and several lines have been fixed up with Scandinavia. There is also a slight improvement in the Continental demand. For the standard sizes, current quotations for coke tins now rule:—IC 14 by 20, 112 sheets, 108 lbs., 19s. 3d. and up per box; IC 28 by 20, 112 sheets, 216 lbs., 38s. 6d. and up per box; with usual options of light and crosses, net cash, f.o.b. Wales.

Scrap.

Generally, it is reported, there is at last some signs of movement in the scrap metal markets, though for the present mainly affecting heavy steel qualities, for which the demand shows distinct revival. On the other hand, inquiries on behalf of iron-founders continue in limited volume, a qualification applying equally to wrought scrap. At Middlesbrough heavy steel scrap is in steady demand, with the price firm at 65s. per ton. There is a scarcity of heavy steel turnings, and these are readily absorbed at as much as 53s. 6d. per ton, with cast-iron borings 52s. 6d. There is a fair demand for heavy cast-iron machinery scrap in handy pieces at 75s. to 77s. 6d., ordinary descriptions making 70s. to 72s. 6d. Heavy wrought iron is very dull, with prices quite nominal at 55s. to 57s. 6d. for bushelling.

Metals.

Copper.—Values on the market for standard copper during the past week reflected the fluctuations of the American exchange, the statistical situation of the metal being practically disregarded. Consumptive demand on this side continues below average, and with the exception of fairly good sales in France, the same may be said with regard to the Continent. Firm reports continue to arrive from America, and in some quarters a higher level of values is spoken of in that country. Considerable sales are reported to have been made on export account, while the domestic demand has improved. Current quotations:—*Cash*: Wednesday, £62 12s. 6d.; Thursday, £62 2s. 6d.; Friday, £62 12s. 6d.; Monday, £62 12s. 6d.; Tuesday, £62 10s. *Three months*: Wednesday, £63 5s.; Thursday, £62 15s.; Friday, £63 5s.; Monday, £63 5s.; Tuesday, £63 2s. 6d

Tin.—Business in the standard tin market on the whole continues fairly active, while the tendency of values during the past week has been in an upward direction. Political events in the Near East are, however, responsible for the occasional fluctuations recorded, consistent buying by large interests having caused "bears" to cover freely, and although the demand from home consumers leaves a good deal of room for improvement, America has at times been a free buyer. Current quotations:—*Cash*: Wednesday, £165 17s. 6d.; Thursday, £166 5s.; Friday, £167 15s.; Monday, £168 17s. 6d.; Tuesday, £169 7s. 6d. *Three months*: Wednesday, £167 2s. 6d.; Thursday, £167 10s.; Friday, £168 12s. 6d.; Monday, £170; Tuesday, £170 10s.

Spelter.—The market for this metal maintains remarkable firmness, the high level of values recently reported being strongly held, due, it is suggested, to speculative buying. Supplies from the Continent continue only on a small scale, but the present level of price is bound ultimately to stimulate production, but meantime higher prices may quite easily be seen. Current quotations :—*Ordinary* : Wednesday, £32 15s. ; Thursday, £32 17s. 6d. ; Friday, £33 2s. 6d. ; Monday, £33 17s. 6d. ; Tuesday, £34 5s.

Lead.—The demand for soft foreign pig continues fairly active, and recent heavy arrivals have been easily absorbed. At present there is no prospect of any increased supplies coming along, while consumers are showing more disposition to secure their forward requirements. America is consuming large quantities, and prices there are maintained at a high level. Current quotations :—*Soft foreign (prompt)* : Wednesday, £25 5s. ; Thursday, £25 5s. ; Friday, £25 7s. 6d. ; Monday, £25 11s. 3d. ; Tuesday, £25 11s. 3d.

Forthcoming Events.

OCTOBER 20.

Society of Chemical Industry (South Wales Section) :—Ordinary meeting at Cardiff. "Congealing Temperatures of Essential Oils," Paper by Prof. W. J. Jones, D.Sc.

OCTOBER 21.

Institution of British Foundrymen (Newcastle-on-Tyne Branch) :—Visit to works of the North-Eastern Marine Engineering Company, Limited, Wallsend. Discussion on "The Problem of Grey Iron Castings," Paper by H. J. Young, F.I.C. (Branch President).

OCTOBER 24.

Institution of Automobile Engineers (Coventry Centre) :—Ordinary general meeting at Coventry.

Sheffield Association of Metallurgists and Metallurgical Chemists :—Ordinary meeting at Sheffield. "Lubricants and Lubrication," Paper by B. W. Methley, F.I.C.

OCTOBER 25.

Institution of British Foundrymen (Coventry Branch) :—Ordinary meeting at Coventry. "Notes on Iron and Steel and Brass Founding," Paper by Dr. P. Longmuir.

OCTOBER 26.

Institution of Mechanical Engineers (Midland Branch) :—"Importance of Testing Materials for Manufacturing Purposes." Paper by P. J. Worsley.

Institution of Mechanical Engineers (North-Western Branch) :—Annual dinner.

OCTOBER 27.

Institution of Mechanical Engineers :—Extra general meeting. Adjourned discussion on "The Use of the Turbo Compressor for Attaining the Greatest Speeds in Aviation." By Prof. Auguste Rateau.

OCTOBER 28.

Institution of British Foundrymen (Newcastle-on-Tyne Branch) :—Ordinary meeting at Newcastle. "Notes on Iron and Steel and Brassfounding," Paper by Dr. P. Longmuir.

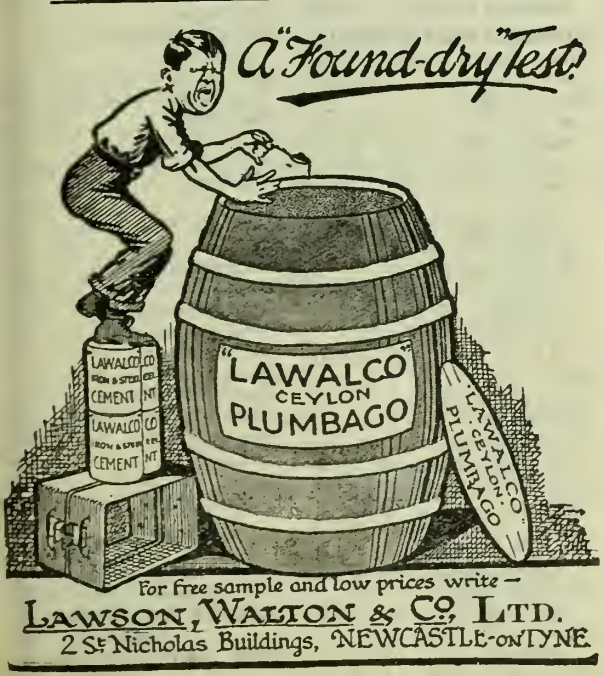
Staffordshire Iron and Steel Institute.—Short address by the President, Mr. J. Payton; address by the Vice-President, Mr. F. J. Cook, on his American experiences in connection with the iron and steel industries.

OCTOBER 31.

Junior Institution of Engineers (North-Eastern Section) :—Informal meeting at Newcastle-on-Tyne.

NOVEMBER 2.

Finsbury Technical College, Leonard Street, City Road :—Streatfeild Memorial Lecture. "The Metallurgical Chemist." By Prof. Cecil H. Desch, D.Sc., Ph.D., F.I.C. 4 p.m.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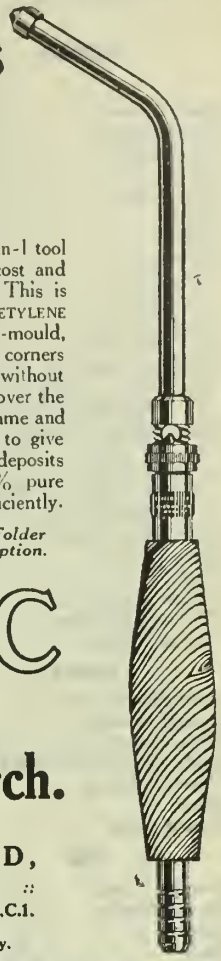

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WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	10	0
Three months	63	2	6
Electrolytic	71	0	0
Tough	65	10	0
Best selected	65	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	71	0	0
Do. Nov.	71	0	0
Do. Dec.	71	0	0
Ingot bars	71	0	0
H.C. wire rods	76	0	0
Off. aver. cash, Sept.	63	3	4⅝
Do. 3 mths., Sept.	63	12	5½
Do. Settlement Sept.	63	2	11⅝
Do. Electro, Sept.	71	3	2¼
Do. B.S., Sept.	67	0	0
Aver. spot price, copper, Sept.	63	2	7½
Do. Electro, Sept.	71	8	1

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d

BRASS.

Solid drawn tubes .. 11⅝d.
Brazed tubes 13½d
Rods, drawn .. .. 10⅝d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

Standard cash	169	7	6
Three Months	170	10	0
English	169	0	0
Bars	171	0	0
Chinese	168	10	0
Straits	169	17	6
Australian	170	0	0
Eastern	172	0	0
Banca	169	10	0
Off. aver., cash, Sept.	160	2	8½
Do. 3 mths., Sept.	160	0	7⅞
Do. Sttlment. Sept.	160	2	3½
Aver. spot, Sept.	160	1	3¾

SPELTER.

Ordinary	34	5	0
Remelted	31	12	6
Hard	25	0	0
Electro 99.9	38	0	0
English	34	0	0
India	26	5	0
Prime Western	33	17	6
Zinc dust	48	0	0
Zinc ashes	11	0	0
Off. aver., Sept.	31	8	8 3/4
Aver., spot, Sept.	31	14	10½

LEAD.

Soft foreign ppt	25	11	3
English	26	15	0
Off. average, Sept.	23	16	3 5/14
Average spot, Sept.	24	2	9

ZINC SHEETS.

Zinc sheets, English	39	10	0
Do. V.M. ex. whf.	40	0	0
Dutch	39	10	0
Rods	44	0	0
Boiler plates	37	10	0
Battery plates	38	0	0

ANTIMONY.

English regulus	27	0	0
Special brands	33	10	0
Chinese	25	10	0
Crude	17	0	0

QUICKSILVER.

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FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 11 5 0
75% 19 15 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% 8/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1 lb.

Ferro-phosphorus, 20/23%, £25

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/11 lb.

Ferro-chrome—
4/6% car. £23 5
6/8% car. .. £22 15
8/10% car. .. £22 10

Ferro-chrome—
Max. 2% car. .. £55
Max. 1% car. .. £68
Max. 0.70% car. .. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £140

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £95

Metallic Chromium—
96/98% .. .. 4/9 lb.

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	3	5	0	3	12	6
Bundled steel & shearings	2	17	0	3	7	6
Mixed iron & steel	2	15	0	3	2	6
Heavy cast iron	3	5	0	3	12	6
Good machinery for foundries		4	0	0		

Cleveland—			
Heavy steel	3	5	0
Steel turnings	2	13	0
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	16	3
Cast-iron scrap	3	11	3

Lancashire—			
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	92/6
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	91/9
Hematite M/Nos.	91/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	80/-
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	105/-
,, No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	102/-
W.C. hematite	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

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Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	15	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	10	15	0
Bolts and nuts, ⅝ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ⅝in.	9	5	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1⅛in.	8	5	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	7 0 0 to 7	2	0
Billets, hard	8	0	0
Sheet bars	6 17 6 to 7	7	0

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
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Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	33.14
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	27.00
Basic	35.46
Bessemer	35.77
Malleable	35.46
Grey forge	34.27
Ferro-manganese 80 % delivered	75.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.47
Steel bars	2.00
Tank plates	2.25
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.90
Sheets, black, No. 28	3.50
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 37/6
,, furnace	26/- to 27/6
Durham & North. foundry	30/-
,, furnace	26/-
Other Districts, foundry	30/-
,, furnace	25/-

THE

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Contents.

	PAGE
An Appeal to British Foundry Owners	335
The Manufacture of Locomotive Cylinders Using Super-heated Steam	336
The Preservation of Iron and Steel	340
An Apprenticeship Course in Foundry Practice—XV.	341
The Influence of Phosphorus on Brass	344
Complimentary Dinner to McLain	344
Institution of British Foundrymen—	
Birmingham Branch	345
West Riding of Yorkshire Branch	347
The British Cast Iron Research Association	349
Correspondence	349
Foundry Vacancies	349
Trade Talk	350
Company News	351
Contracts Open	351
Gazette	351
Deaths	351
Iron and Steel Markets	352

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

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An Appeal to British Foundry Owners

Readers of this journal are aware that an International Foundry Congress and Exhibition is to be held in Paris during the second week of next September. It is now authoritatively announced that the Americans will send no less than 50 delegates. They are already getting busy. What are the British foundry owners doing?

At the next meeting of the General Council of the Institution of British Foundrymen it will most probably be decided that the annual Convention will be held at Manchester, under the presidency of Mr. Oliver Stubbs. The appropriateness of the venue is unquestionable, as during Mr. Stubbs' last term of office industrial conditions prevented the holding of the Conference in his home town, and a belated but successful meeting was held in Blackpool. However, it should not be lost sight of that it is largely owing to the initiative of Messrs. Stubbs, Flagg, Estep, Ronceray, Ramas and Leonard that the International Congress is to take place. What steps are the Institution of British Foundrymen taking? At the last General Council meeting, an invitation to hold the Conference in Paris was turned down, as it was felt it would not be sufficiently representative.

The Americans are sending a delegation of 50 foundrymen several thousands of miles, but the expenses of such delegates will be paid by the foundry owners. Are British owners prepared to send their managers, foremen, or skilled men a few hundreds of miles? If it is worth while for the Americans, it is obviously worth while for the British. The answer, that the question can be considered later, is dangerous, because it is only by co-operative efforts that the French foundrymen can make adequate arrangements for their reception. Additionally, a co-operative effort makes for economy, and often comfort.

The French in the annual gatherings make a special feature of works visits, and the neighbourhood of Paris abounds with excellent foundries, automobile, art and jobbing being especially well represented. Again, Paris can be considered as not merely the capital of France, but of Continental Europe, as from there railways radiate to all countries, bringing with them both exhibitors and buyers. It is not a case of one cannot see one's way clear to go, but one cannot afford to stay at home, or at least be represented.

For this particular meeting wo make a special appeal to metallurgical professors and teachers on two grounds. First, the Exhibition and Congress is being held in the Ecole des Arts et Métiers, which contains the finest model foundry in Europe; and, secondly, the mixing with practical men for a few days will bring them in very direct association with the industry they have to serve.

Since the Institution has not announced its intention of organising a visit, we feel that the duty devolves upon THE FOUNDRY TRADE JOURNAL.

We suggest that, as the bulk of the foundries are in the provinces, the Southampton-Havre route is preferable, as it eliminates staying a night in London. Providing the franc exchange remains reasonably within its present range, we are of opinion that the cost could be kept within the means of the majority of foundrymen. The scheme we have envisaged is to provide a ticket covering travelling and hotel expenses. The programme in Paris would be arranged in co-operation with the French Foundrymen's Association. To this cost there would have to be added a tourist ticket to London. We shall be pleased to hear from owners and others who are interested, so that it can be ascertained at an early date whether the scheme is worth while our organising or not. Obviously, the sending in of a name does not in any way bind the writer to go forward. In order to facilitate matters, a coupon has been printed at the bottom of page 16, which merely requires filling in. This should reach us before next Thursday.

An objection which has been raised is the language difficulty. We can assure those who have never visited Paris that English is spoken everywhere. In one large establishment employing 4,000 hands, no less than 1,000 speak English. At the Conference, all those who speak English will have a small enamel Union Jack suspended from their badge.

We consider the occasion of sufficient importance to warrant discussions being held in every foundry in Great Britain to consider the best means of assuring the maximum representation from each foundry. Finally, if it is worth the while of America to be so extensively represented, it should need but few words of ours to indicate that it is at least worth the while of all British foundrymen to be placed on our list, so that they may be informed as to its development.

The Manufacture of Locomotive Cylinders Using Super-Heated Steam.*

By A. F. Gibbs, M.I.Brit.F.

For the sake of clearness this Paper has been divided into three parts—moulding, casting, and practical results.

MOULDING.

This class of cylinder is known to railwaymen as the "S69," or 1,500 class. They are the well-known piston-valve type, which have replaced to a very large extent the slide-valve type of cylinder.

Fig. 1.—Lowering the Exhaust Core into Position. Note the Hook Bolt for Securing in the Mould.

The merits of the one or the other will not be discussed, as being irrelevant to the subject from the foundrymen's point of view. The method of moulding adopted is a combination of dry-sand and loam-moulding. For moulding purposes the bottom half of the pattern is placed upon a flat board, the face of the pattern being slightly damp in order that the parting sand will adhere to it. The pattern is then faced up with loam, which consists of a mixture of new and old sand, cow hair, and horse manure, to an average thickness of about 3 in. This is then wire-vented, and covered with a coating of clay wash. The bottom box part or drag is then placed on a board, and rammed up with core sand. After this the board is clamped to the box part, and the whole rolled over by means of the 15-ton circular sling chains.

Special stays, shaped to fit fairly closely to the pattern, are fitted in both the bottom and top parts of the box. The joint is then made, and the

Fig. 3.—Lowering the Lightening Core into Position. Of the 32 Cores used this is the only one requiring Chaplets.

middle part of the pattern placed in position. This is then loamed up, being treated in exactly the same manner as the bottom portion. After another parting joint has been made, the top part of the pattern is added. No useful purpose can be served by describing the operation, as it closely resembles what has already been said. Obviously, the gates of the runner are placed on this pattern, being carefully loamed and rodded. Additionally, one or two hooks or gaggers are necessary in this part, despite the specially-shaped stays, which carry most of the load, but there are several pockets of sand which need additional support, as when the moulds are being transferred to the drying oven considerable jarring often takes place.

After the top is rammed up, the down stick or runner, together with the four riser sticks, are

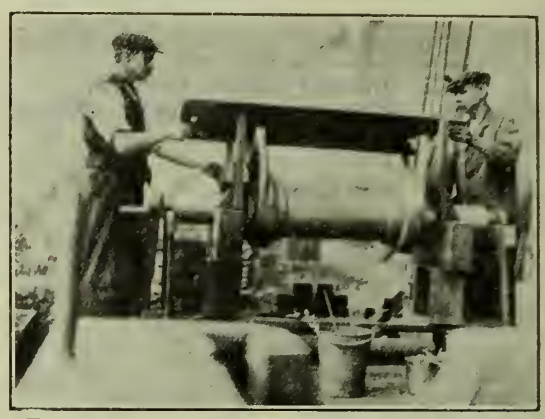


Fig. 2.—Using the Template for Correcting the Position of the Port Cores.

withdrawn. The mould is now taken apart, and the pattern withdrawn, after which the mould is finished in its green state. The moulds are now placed on the trolley ready to enter the drying oven for their first stage of drying, which is carried out at 245 deg. C. for 18 hours. This done, the mould is removed from the oven and a coating of plumbago wash applied. It is then re-stoved for a further 18 hours. The next morning the mould is finally withdrawn from the stove, and is cored up. It will be noticed from the illustration that the exhaust core is provided with a hook bolt for attaching it and preserving its position. This is really more than an exhaust core, as the designer has co-operated with the pattern shop and foundry foreman, and it contains four prints for the piston-valve body-core. It additionally forms part of this body core. The illustration (Fig. 1) only shows half the core, the top half being made in two pieces.

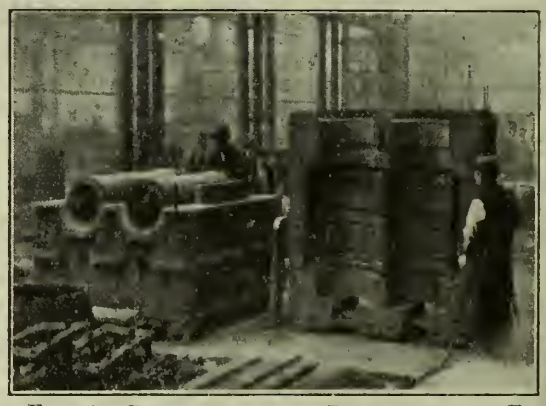


Fig. 4.—Blowing-out the Dust from the Top Part before Closing.

The piston-valve body-core, with the port cores attached, are the next to be placed in position. The illustration (Fig. 2) shows the template board and duplicate prints. The main barrel or body cores, shown in Fig. 3, are in course of construction. The core iron attached to the end of the barrel by means of wedges should be noted. Lightening cores are used to ensure the production of walls of equal thickness. It is the only core out of a total of 32 which necessitates the use of chaplets to preserve its position, this being the last core to enter the mould, which is now re-stoved

* Paper read before the London Branch of the Institution of British Foundrymen.

for the night. The following morning the moulds are brought out and made ready for casting.

It is essential that the four cylinder-cock cores are securely fixed in position. The moulds being closed, a joint is loamed up by a labourer, after which he fastens the three parts together by means of a number of ⅞-in. bolts. The completed mould is now lowered into the casting pit, where the riser cups are made up, and the runner box placed in position. This runner box measures 4 ft. 6 in. × 20 in. wide × 20 in. deep. Its approximate size when loamed up is 50 in. × 18 in. × 15 in., and it has a capacity of 30 cwts. It may seem that this runner box is too large, and altogether too pretentious, but experience at the Stratford works has shown that it is a paying proposition for any work which must be clean to give just as much attention to the runner as to the moulding itself. Therefore this runner box is lined with loam, dried in the stove, and then black-washed.

CASTING.

It is the practice at the Stratford works to run about three tons of hard iron through the cupola before taking the cylinder iron. Some six sieves of coke are placed on top of this three tons to effect a complete, or at least a partial, separation of the two classes of iron. The cylinder iron is now charged in the cupola, which has a capacity of five tons per hour. Usually it is made up into 8-cwt. charges, with two sieves of coke between each charge. The actual method is 4 cwts. of pig-iron, 4 cwts. scrap, followed by the coke and chalk. After the eight charges, three to four sieves of coke are added to check the on-coming different metal mixtures. The pressure gauge on the blast usually indicates 1 lb. per sq. in. Blast is furnished by four motor-driven Roots blowers.

Special attention is always devoted to the upkeep of ladles, which, if at all dirty, are invariably relined. It requires about three tons of metal to cast these cylinders, the amount being measured to within a ¼ cwt. by means of a gauge. In one case, with the Chatelier pyrometer, it was found the end of the pyrometer fused. A Fery radiation pyrometer has also been used to ascertain the temperature, but there is some difficulty in obtaining a true reading.

After leaving the furnace the slag is skimmed from the top of the metal. When approximately the correct pouring temperature is reached, the casting is teemed. For the actual pouring, the runner box is filled with 30 cwts. of metal, the plug withdrawn, and the runner box kept quite full until all the metal has left the ladle. Usually there remains about 2 to 3 in. of metal in the runner box itself, but this metal is taken out as soon as possible, care being taken not to do this too early, otherwise internal pressure in the moulding may cause the casting to drain slightly from the mould, resulting in a waster. The actual time taken in pouring a mould of this character is just over two minutes from the time that the plug is withdrawn.

PRACTICAL RESULTS.

The cylinder mixture used is made from 25 per cent. of Warner's cold blast, 25 per cent. hematite, and 50 per cent. scrap. Tests show it to withstand 14.1 tons per sq. in. tensile, and when bend tested between 12 in. centres gave 1.30 tons. Between 36 in. centres, 1.8 was registered, and with this there was associated a ⅝-in. deflection. The analysis was returned as:—Gr.=3.8 per cent.; C.c.=0.71 per cent.; Si.=1.61 per cent.; S.=0.16 per cent.; P.=1.0 per cent., and Mn.=0.32 per cent. However, since the lecture the author submits the following as being more representative:—Gr.=2.57 per cent.; C.c.=0.61 per cent.; Si.=2.02 per cent.; P.=0.77 per cent.; Mn.=0.50 per cent., and S.=0.125 per cent.

The average mileage accomplished to date by the cylinders described is 260,000.

Conclusion.

It is not claimed that the latest and most up-to-date method of manufacture of cylinders has been set out, but when it is taken into consideration that, though these cylinders have been manufactured at Stratford since 1912, not one waster has been produced right up to the writing of this Paper, and during this period 145 have been made. With four other classes of cylinders something at less than 1 per cent. of wasters is made, the average output being 132 per annum.

DISCUSSION.

The Branch-President, in opening the discussion, first congratulated Mr. Gibbs upon his lecture. In the course of his remarks, Mr. Gibbs had mentioned that unless they had a proper floor and proper carriages they would get considerable vibration. The time had come when the Institution of British Foundrymen, with their Charter behind them, should be able to raise the status of the foundryman, so that, instead of being the Cinderella of the engineering world, the foundry should be one of the principal shops; they should be in a position to expect proper carriages and a proper floor. He had been struck by the remark made by the lecturer that the moulds were stoved for two periods of 18 hours, for a casting weighing 3 tons. He asked Mr. Gibbs whether his stoves were properly ventilated, because he had seen a considerable number of stoves in which the atmosphere had been churned round and round, and there was no direct means of getting the moisture out of them. He would hardly have thought, with efficient stoves, that it would be necessary to stove a mould for a 3-ton casting for so long a period. He was pleased to notice that Mr. Gibbs had a casting-box, because he believed that a casting-box was the proper thing. Another thing that pleased him was that the G.E.R. works at Stratford were sufficiently up-to-date to use a pyrometer. With regard to the end burning off, he suggested the use of a fire-end of graphite. With a Féry pyrometer, he did not think they could expect to get accurate temperature readings when dealing with cast iron. He had been struck with the analysis of the metal: 1 per cent. of phosphorus appeared to him to be rather high, but how could they quarrel with the composition when they saw the results in mileage of engines fitted with these cylinders? Cylinders made in 1912 and 1913 were not yet worn out, and Mr. Gibbs expected them to last another 12 years. When they obtained a mileage of anything in the neighbourhood of 260,000 he did not think they could adversely criticise the metal, bearing also in mind that the output of cylinders was given by Mr. Gibbs as 132 per annum, 99 per cent. being good castings. He had examined quite a number of cylinder castings during the last 10 years, and was under the impression that steel castings had come somewhat into vogue, particularly for superheat steam locomotives.

Steel Loco-Cylinders.

He was rather surprised to learn that the G.E.R. still continued to use cast-iron for all their cylinders. A number of the steel cylinders which he had examined contained small blow-holes; it was quite likely that such blow-holes as he had seen were in positions which mattered little, but no trouble was taken even to stop with "filling." However, if a cast-iron casting would stand up to superheat temperatures, which nowadays ran up to 340 deg. C., then, having regard to the difficulties encountered in casting these complicated cylinder castings in steel, he could see no reason why cast-iron should be given the go-by, and steel introduced. Perhaps Mr. Gibbs would say whether he had any knowledge of the advantages to be gained by using steel for cylinders, as compared with cast-iron? The paper was short and crisp, and he hoped members would discuss it whole-heartedly.

Pouring Considerations.

Mr. J. Ellis expressed his gratitude to Mr. Gibbs for having come forward and described his methods, and thus exposed himself to criticism. He asked Mr. Gibbs if he would tell him the position of the test-bars on the cylinder. He had noticed that the cylinders were run from the top, and evidently very good results were obtained thereby, but there were many men who had pet ideas as to how to run a cylinder. Some poured from the bottom, and made quite a good job. He instanced a case in which a man in his foundry made a cylinder weighing about 6 tons, and poured it from the top, obtaining quite a good casting. Some 18 months later another man came into the foundry and ran a similar casting from the bottom, which also turned out quite good. Both men were excellent workmen. With regard to the gauging of the cores, the method described did not seem to be up-to-date. The old-fashioned

way of using blocks of wood was very risky, because the blocks might move. He had seen a frame or cradle used by means of which all the cores could be set out and gauged absolutely correctly. He liked the idea of the very strong moulding boxes, which was undoubtedly good. The mixture of metal seemed to him to be rather high in pig-iron, namely, 50 per cent. He had not the least doubt that many of them had made cylinders with a mixture containing less pig-iron, provided, of course, that the scrap was selected. One might almost say that in some cases they could make cylinders with scrap only, but they must know the nature of the scrap. He did not know whether Mr. Gibbs had noticed any defects arising in the cylinders after having been in use for some years. He mentioned that because, on one occasion, when he had bought some scrap, there was a cylinder weighing about 5 tons. It was a reciprocating engine cylinder for a marine engine, and had been cast crown upwards, and when breaking it up he had discovered that there was a hole about 1 in. wide running over one-third of the area of the crown. The metal was aout 1¾ in. thick, and the hole had been filled up with lead, and yet the cylinder had been at work for 20 years. He was able to trace the makers, and was able to find some of the moulders who knew all about it. That reflected upon foundrymen, because if the inspectors, when inspecting a cylinder, saw a little pin-hole in it, they would sometimes condemn it. He remembered a case in which a Government inspector had inspected a casting weighing about 15 tons. They had not yet got over the difficulty of a crease in a loam mould. Sometimes there was a little crack in the mould, which was filled in by the moulder, and when casting the air got into that crack and pushed the filling out, leaving a little indentation in the casting. He had seen the inspector write "condemned" across the casting because of that. It had taken him (Mr. Ellis) three weeks to get that casting passed, and a Committee from the Admiralty, as well as experts from various shipbuilders, had examined it. Therefore, the products of the foundry had to face very severe inspection.

Teemings Speeds.

Mr. C. A. Otto felt that Mr. Gibbs had left out quite as much as he had given in his haste to get the Paper finished in time to allow of a good discussion That was quite unnecessary, and Mr. Gibbs might have carried on a little longer. He would like to know whether the job was cast quickly or slowly, because with a head of metal such as the receiver contained, about 25 or 30 cwts., if that were kept full, and the metal fed the mould slowly, it would result in a different casting from that which would be obtained by pouring more quickly. Though the size of the down-runner had been given, the area of the runners supplying metal to the mould must also be considered. Mr. Gibbs had referred to steel in connection with these castings. High-pressure turbines were made in steel, and this was most intricate work, equally as intricate as the cylinder described. He thought that the experience gained in this country during recent years in connection with steel would be of advantage in turning out castings of equal intricacy as those under discussion.

Analysis Queried.

Mr. A. R. Bartlett expressed surprise at the analysis of the metal used, especially so far as the silicon and phosphorus content was concerned; they were both rather high. He assumed that in superheated steam work the silicon would be rather on the high side. He would like to know the number of the pig-irons used and also where the phosphorus came from. The description showed that there were core carriages on a sand floor, which seemed to be rather unwise, and hooks, etc., had been put in the cores to withstand the jar. It would be a wise policy to get that altered and so avoid that trouble. There was one point in connection with the moulding box, and that was the position of the trunnions. It seemed to him that the thing was being turned on the trunnion in the wrong direction. If that trunnion were on the opposite way, it would be turning on the bridge of the mould instead of turning crossway on with the possibility of a fall-out. He would also like to know the dimensions of the runners. As to running, he agreed with Mr. Gibbs' practice of running from the top. He believed that was right, especially if the runners were not too large, because he would get the best metal at the top. He believed, in connection with running cylinders, that as a general rule—although every one was dealt with on its merits—it was best to run from the top, because then the best metal was at the top of the casting, where otherwise when running from the bottom they were pushing up the dull metal, and that had a tendency to catch underneath the cores. Unless the casting were of extraordinary depth, it was wise to run from the top. He would also like to know if Mr. Gibbs could say the number of ounces of blast that he used.

Runner Cups.

Mr. H. O. Slater, referring to the mixture, asked if the lecturer melted the iron once, poured it, and then re-melted again for the actual casting. With regard to runner cups, he believed that the small runner cup sometimes was responsible for a large amount of dirt in the cylinder. He was pleased to see the method adopted by the lecturer in keeping the runner box filled during pouring. He also agreed with the system of leaving a certain amount of metal in the bottom of the runner box after the casting was made, in order to avoid porosity, caused by the expansion of the core irons and cores, and so on, pushing the metal out. He had noticed that there was a fairly large air outlet from the core, and he asked the lecturer if, from his experience, this had caused porosity through the hot air coming in contact with the atmosphere or by the metal getting into the barrel.

Mr. J. D. Hotchkiss, dealing with the merits of cast iron as against steel for cylinders, said that cast iron had self-lubricating properties, and he did not know whether that had anything to do with the difference between the two metals.

Mr. G. C. Pierce said he spoke with some diffidence, because Mr. Gibb had said that his works turned out 132 cylinders per annum, and seldom saw a waster, and he felt that he was treading upon rather delicate ground. At the same time, he would like to know why the moulds were faced with loam. He had seen a great deal of cylinders cast in a similar manner to those at the G.E.R. works, but the cylinders took longer to make in that manner than in the ordinary good dry-sand manner. There was a lot to be said for loam casting, but on this particular job he was of the opinion that much time could be saved by using dry sand.

Separating Charges.

Mr. V. C. Faulkner said, with regard to the practice of putting layers between the metal in the cupola, Dr. Moldenke, at the last meeting of the American foundrymen, had pointed out that this method of putting in layers was no use at all. He had shown from experiments that with nickel chrome pig-iron he could not separate the charges in the cupola. Yet the lecturer pointed out it was his experience that this could be done. With regard to the analysis of the metal, some metallurgists had stated that the manganese should be four times the sulphur, and that they could put in as much sulphur as they liked, provided it had manganese in it. Mr. Young maintains that cast iron is a very difficult thing to analyse; these cylinders were giving good results, and he doubted whether the manganese was not a bit higher and the sulphur a bit lower. Having had some experience of the Féry pyrometer, he believed, from the technical point of view, that this gave bad results, because they always had a cloud of smoke in front of liquid metal.

Chemical Composition.

Mr. A. Whiting, referring to the analysis of the metal, said he believed that, generally, Warner's and hematite contained about 0.05 phosphorus, and yet the mixture contained 1 per cent. phosphorus. As the Warner's and the hematite constituted 50 per cent. of the mixture, the scrap must have contained nearly 2 per cent. phosphorus. He would like to know what scrap was used, and what was its phosphorus content, because he could

not quite see how Mr. Gibb could get a mixture containing 1 per cent. phosphorus, having regard to the low phosphorus content of the Warner's and hematite. Also, with regard to the poring temperature, by the time the metal was taken from the furnace in the ladle, and skimmed off, the temperature must drop before the actual casting took place. He had found from experience that cylinders should be cast with the metal as hot as possible.

Steel *v.* Cast-Iron Cylinders.

The Branch President spoke with regard to the merits of cast iron and steel for cylinders, and a remark which had been made that cast iron was a more or less self-lubricating metal. One of the greatest difficulties to be faced was the efficient lubrication of these cylinders under super-heat conditions. Graphite, in some form or other, was sometimes used in order to get over the trouble, but at the temperature of super-heated steam, even with forced lubrication, it was certainly difficult to get efficient lubrication. In steel cylinders, steel pistons with bronze rims were being used, in order to have the bronze working on the steel, rather than having steel working on steel. These bronze rims had proved successful, and it was possible that they might be made even more so in the near future. They would all understand that if they were putting a bronze rim on a steel piston, it was preferable that the bronze rim should wear rather than the cylinder, because the cylinder casting was very much more expensive to replace than a new bronze rim on the piston. With regard to the pouring temperature of the metal, 1,250 deg. C., several remarks had been made with regard to the fall of temperature during the tapping, the skimming of the metal, etc., before the actual pouring. As a matter of fact, what they were really talking about was the life of the metal; they did not lose very much in actual temperature.

Mr. H. O. Slater asked if the remark applied to iron or non-ferrous metal.

The Branch President said it did not matter what the metal was, the fall of temperature was dependent upon radiation and conduction losses. The losses when using a heated loam-lined ladle were comparatively small unless the ladle was standing in a strong draught of cold air. He recognised that there was such a thing as "life" in cast iron, and it was not so much a matter of fall in actual temperature as the condition in which the metal was when about to be poured.

Mr. Faulkner asked the Branch President how he reconciled his statement with the views of Elliott, who was of opinion that the temperature dropped considerably.

The Branch President asked what was the bulk of the metal.

Mr. Faulkner replied that that was not stated.

The Branch President pointed out that the bulk was of considerable importance.

THE AUTHOR'S REPLY.

Mr. Gibbs, in reply to the discussion, dealt first with the Branch President's remarks as to pouring temperature, and the questions which had been put with regard to the temperature drop. He backed up the Branch President's statement that the temperature did not drop quickly, for often, after the ladle had been away from the furnace, and the metal had been skimmed, the cylinder ganger had had to agitate the metal for quite ten minutes in order to help it to cool down. With regard to the casting of test-bars, those for tensile were cast in the upright position, and the long ones in the flat position. At the same time, they were not cast on the cylinder. The method was to cast them in separate boxes, and they got a shank of metal out of the cylinder ladle after the ladle was full, but he would not say that that was up-to-date practice. With regard to the heating of the stoves, mentioned by the Branch President, he admitted that there was a failing there. As a matter of fact, the stoves at Stratford were heated by hot air; they were not in direct contact with the fire itself, but the air came through the flues. They had certainly not an air inlet circulating the hot air around, and that probably accounted for the somewhat prolonged drying they had to give the moulds. At the same time, they had to bear in mind that the moulds were faced with loam instead of sand, about 3 in. thick, and they therefore required more drying. It might be thought that that was unnecessary; Mr. Pierce had suggested that it would be quicker to face them up with sand instead. Whilst admitting that the Great Eastern Railway cylinders probably took longer to make, he pointed out that the percentage of good castings was very high. He was quite willing to admit the possibility of saving time, but, on the other hand, when they had such a large percentage of good castings they were very chary of making a change. With regard to the phosphorus content of the mixture, he admitted that there was a low percentage of phosphorus in the Warner's and in the hematite. As to the number of Warner's and of the hematite, it was supposed to be No. 1 in each case, but he could not be too sure about it. A question had been asked as to whether the metal was re-melted first. The pig-iron had not been re-melted. The usual practice was to run about 10 cwt. of scrap down the pig bed on the evening before casting, in order to cleanse it. That was the only re-melting that was done, and they picked up considerable dirt from the pig bed in that way. He did not know whether or not it was beneficial to re-melt. They had cast plenty of cylinders without any re-melted scrap at all, and they had been just as good as the others. With regard to the phosphorus content of the scrap, he would say that it was fairly high; the Staveley pig No. 3 was fairly high in phosphorus (1.38 per cent.). He had photo-micrographs of all the pigs used in the foundry, and had confirmed this. He was sorry that he had not another analysis taken to back up the one he had given. As to the sulphur and manganese content, mentioned by Mr. Faulkner, he had had no experience with regard to the manganese content being twice as large or four times as large as the sulphur content. Possibly it would be beneficial, because, from his own experience of metallurgy, if he had a metal high in sulphur, he liked to have a high manganese content also. They would then remove some of the sulphur as manganese sulphide in the slag. Dealing with Mr. Faulkner's remarks about Dr. Moldenke, with regard to the separation of charges in the cupola, Mr. Gibbs said he had a great regard for Dr. Moldenke, but if the members had read what Dr. Moldenke had written on a furnace charged by means of an elevator, they would have found that he had said quite the opposite to what Mr. Faulkner had quoted. He did not agree with what Dr. Moldenke had stated with regard to the separation of charges. His own practical experience had told him that he could separate the charges. For instance, at Stratford they invariably started with hard iron, then wheel iron, cylinder iron, and then ordinary mixture. They had a wheel weighing 16 cwt.; they put one ton on for that, and he would not care to think that he had missed the biggest part of the wheel iron. The fact remained that the iron was in the furnace, and it came down into the melting zones. It was melted, and it went to the well of the furnace. He contended that if they were tapping close, as the metal melted they would receive the amount of charge put in, if weighed in carefully. They had to watch that they tapped low down, and know what they got out as well as what they put in. He did, to a large extent, believe in the separation of charges. If it were proved conclusively to him that the charges could not be separated in the cupola, he would have to go back and say that they had better have all ordinary iron in the foundry. As to the stove carriages and floor, he was sorry that Mr. Bartlett had noticed that the stove carriages were antique. They were hoping to get the foundry more up to date in the near future, and radical alterations were being made. As to the trunnions, he could hardly follow that the position of these were incorrect. The mould was certainly turned up on the trunnions, with the opening of the body core downwards, and as to the jar of the mould when turning on the trunnions, there was practically no jar; the mould went over fairly steadily. If there had been jarring out, it was when the stays of the box were rusting out, and they had then put new ones in. Otherwise, he did not think the trunnions in the box were wrong. In regard to the area of the runners, running at the top, and the dull metal getting under the cores when running from the bottom, he agreed with all that Mr.

Bartlett had said. He had had similar experience. Coming to the area of the inlets, he admitted that the area of the inlets was much greater than the downright, and the downright was 2¼ in. diameter. To be logical, they should have the area of the inlet a little smaller than the area of the downright, but the system they were using was introduced long ago, and everything was going all right. Therefore, why change it?

Mr. Slater suggested that that was compensated by the size of the runner cup.

Castings Made Without Feeding Heads.

Mr. Gibbs said that once the plug was withdrawn, and the pouring of the metal actually commenced, the metal finished sinking down in less than two minutes. He had not adopted M. Roneeray's method of slow pouring, yet, so far as cylinders were concerned, but at his works they had poured one or two castings in this way quite satisfactorily. The Branch President had referred to the tapping of one ton only. First of all, the furnaceman started off with a little more than one ton, but he tapped the three tons in three taps, and the average was one ton each time. He had never had any experience of casting steel cylinders, and the super-heater header castings he had mentioned, which were made in Belgium before the war, were the only steel castings they had dealt with. They were made during the war, when the best men were not available. But since being made of cast iron in the Stratford foundry every satisfaction had been obtained. It was more difficult to get a sound steel casting than a sound cast-iron one, and he did not know of anything against cast iron, so far as its life was concerned from a cylinder standpoint. In the piston-valve cylinders they had liners, not made of steel, but of cast iron, as were also the piston heads. With regard to the use of wooden template blocks, mentioned by Mr. Ellis, he agreed that the use of these was old-fashioned. But the template was also used inside the mould, but the preliminary fitting only was done outside the mould. The core was not loamed up until it had been tried in the mould. With regard to defects in cylinders, he could not quote any, except that they had had the super-heater cylinders returned with cracks in the flanges. It had practically been admitted by the drawing office, however, that this was a slight fault in the design. The flanges were not strong enough, and the cracks started from the holes where the cylinders were suspended from the frames. The flanges had therefore been enlarged, and since then—two years ago—they had had no cylinders returned, so that apparently the trouble had been cured.

Mr. Gibbs said the barrel for the core of the bore was left open. He had found no defects owing to the ignition of gases. The barrel was made very firm. They might possibly get that defect with a flimsy barrel, but with a stout barrel there was no defect of that sort.

Vote of Thanks.

Mr. A. R. Bartlett proposed a very hearty vote of thanks to Mr. Gibbs for his Paper. It was very clear and explicit from the foundry point of view, and they must compliment him on the very successful results of his work. He was of opinion that the very successful castings obtained were due to the fact that there must be some very good cupola practice which Mr. Gibbs had not given. Speaking of cupola practice, it seemed very strange that at Stratford they only tapped one ton, and then had to bod in. Why not tap three tons? He had seen fifteen tons tapped without bodding. He suggested that the tapping hole was out of proportion to the metal, and if Mr. Gibbs had the hole a shade smaller, it would be better.

Mr. F. J. Wares seconded the vote of thanks, which was accorded with acclamation.

Mr. Gibbs, in expressing his thanks, said the reading of his Paper had given him very great pleasure. Answering Mr. Bartlett's last question, he said that the well of the furnace only held one ton, perhaps slightly more at times. With regard to the tapping hole being too big, he pointed out that sometimes it was too small.

The F. S. Pearson Engineering Corporation, Fisk Building, New York, have now re-established a department for industrial management and technical auditing of industries and public utilities.

The Preservation of Iron and Steel.

In his Presidential Address to the Oil and Colour Chemists' Association, on October 12, Dr. J. Newton Friend dealt mainly with experiments he had carried out in regard to the preservation of iron and steel from rust and corrosion. As illustrating the importance of the subject, he referred to the estimate made by Sir Robert Hadfield that 28,000,000 tons of steel were lost annually by corrosion, and said that, if we took an average of £20 per ton, the monetary loss amounted to nearly £600,000,000 per annum. Dr. Friend added that he knew a Midland firm which had calculated that the painting of their works worked out at £1 per ton of metal surface painted per year, and the annual cost of painting at, say, £10,000. The painting had to be done every year. Hence the subject of preventing the rusting and corrosion of iron and steel had become one of supreme economic importance.

Dr. Friend then dealt with the results of the experiments he had carried out at Birmingham and Worcester, in conjunction with his students and alone. A number of mild steel plates, charcoal annealed, and thoroughly cleaned, were painted with a definite quantity of paint, and were exposed to the air in the form of a fence in the Valley of the Severn. Altogether, the plates were exposed for five years, but they were examined at various periods, and the loss after one month in the case of five precisely similar plates was quite different. In the case of plate No. 1, the loss was 1.55 grammes; plate No. 2, 1.25 grammes; plate No. 3, 1.35 grammes; plate No. 4, 1.60 grammes; and in the case of plate No. 5 the loss was 3.95 grammes. In all sets of plates it was found that there was one which was more erratic in its behaviour than the rest, and this was probably due to some physical or chemical difference.

Discussing the functions of a perfect vehicle for paint, Dr. Friend said it should protect the painted surface, bind the pigmentary particles, and expand and contract with the painted surface. As regards linseed oil as a vehicle, this rapidly absorbed oxygen, giving a clear substance known as linoxyn, the chemical composition of which was still a matter of discussion, but it was this fact which gave linseed oil its good properties over any other vehicle.

Passing on to the perfect pigment, the functions of this were:—Mechanical support to linoxyn, reduction of paint permeability, increase of viscosity, and reduction of the amount of expansion on setting. A greater degree of perfection had been reached in pigment than in oil. Experiments had been made with red, black, and white pigments, and it had been found that in the dark all three behaved similarly, but in the light oxidation was very much more accelerated in the case of white.

Another important point was the fineness of the pigment. The finer the pigment, the more thoroughly would it become incorporated with the oil. His experiments showed that after a pigment had been ground to a good commercial quality, say 200 mesh, then it had reached an efficient state of sub-division, and much finer grinding would only affect the paint to a small extent. The best result appeared to be obtained with 60 per cent. of pigment, which was about the percentage which practice had found to be best.

His experiments had also shown that several thin coats of paint retarded corrosion better than one thick coat. Actually, the best results were obtained with one thin and one thick coat of paint, so far as prevention of corrosion of steel was concerned. Whereas, however, in the case of surfaces exposed to the air, an increase in the total thickness of the paint prevented corrosion; with subaqueous surfaces there was an optimum thickness of paint, after which corrosion increased enormously. That optimum thickness was about 7 to 9 lbs. per 100 sq. ft. in the case of the subaqueous tests that he had made. Finally, reference was made to the effect of leaving mill scale on steel as a means of preventing or retarding corrosion. Although mill scale was a means of preventing corrosion, the point was that, in making up steel, the scale was broken in various places and moisture got in at these places and set up corrosion.

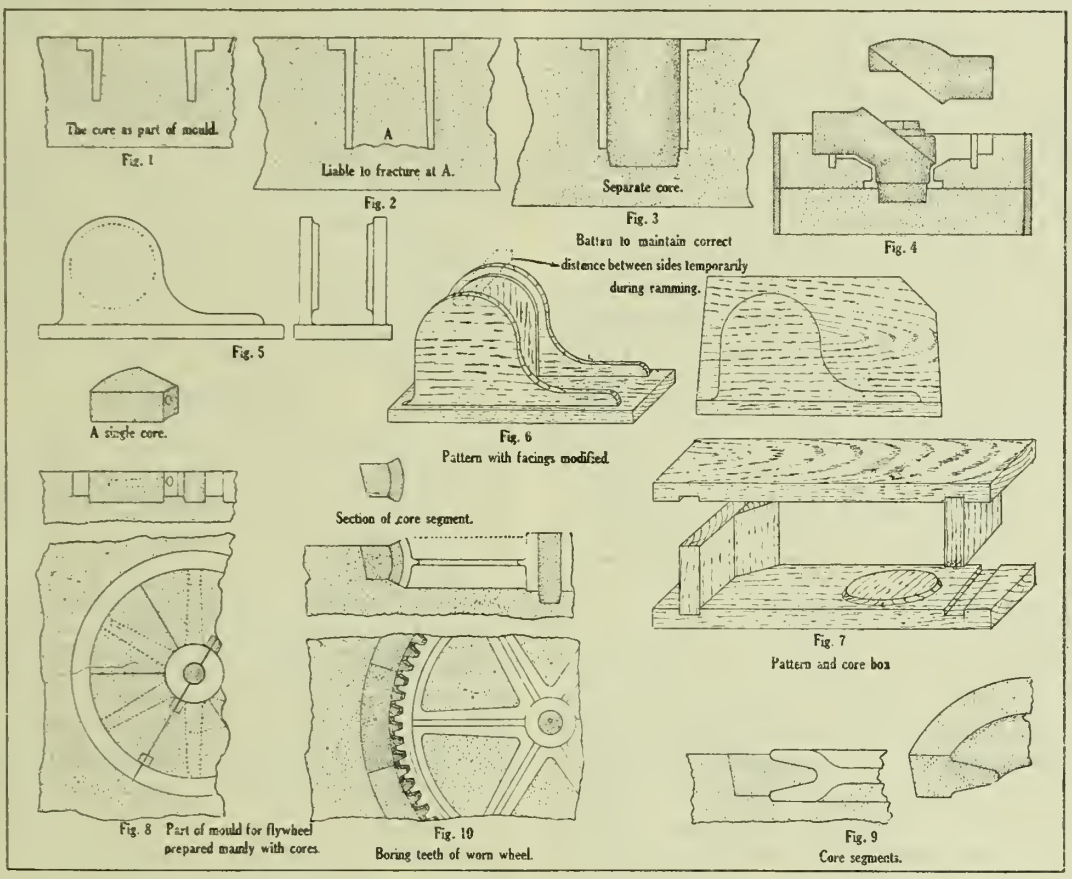
An Apprenticeship Course in Foundry Practice.—XV.

By Ben Shaw and James Edgar.

CORES AND CORE MAKING.

Part 1.

Core making is usually referred to as having particular reference to that part of a mould which gives the central or internal shape of the casting. Although this explanation is suitable for giving general expression to the term, it is in practice applied to any body of sand prepared separately and introduced into the mould after the pattern has been withdrawn, and whether it defines the internal or external shape of the casting. The expression is also applicable to certain bodies of sand which are prepared in the mould, but in such a manner that they can be lifted separately, either in order to facilitate the withdrawal of the pattern or to allow other cores to be introduced. In a broader sense, the term core is also applied to the central body of sand left in the mould when the pattern is withdrawn, even though the temporary lifting of this body of sand may be unnecessary. Thus any body of sand which defines the internal shape of a casting, whether it be lifted or not, and any loose body of sand used for the external shape of a casting, may be termed a core, although in many instances other terms are applied to distinguish between various kinds of cores. Generally speaking, when the pattern-maker supplies suitable facilities for making the body of sand of the requisite shape, whether by means of core-box, strickle, core-frame, core-plate or skeleton shell pattern, the term core is applied, but when a full pattern is supplied from which the internal shape of the casting is obtained when the pattern is delivered, the central body of sand is frequently referred to as a "cod," and this expression is often used, even though it may be lifted temporarily. There is another type of core for which the moulder is mainly responsible, as no facilities are supplied to him other than the pattern—we refer to loose parts of the mould made to free the pattern or to introduce other cores, and when the moulder determines the shape, being guided only by the pattern; these loose pieces are sometimes referred to as "false cores," though they are more familiar as "drawbacks." To prevent any confusion in the use of these various terms we shall confine ourselves to cores which are made separately, and to those made in the mould from skeleton shell patterns.



Why Cores are Used.

Broadly speaking, the need for the use of cores comes under two categories—they are either a necessity or they may be used as an expedient. Cores may be said to be a necessity when the construction of the mould would be practically impossible without their aid, or even though the construction may be possible, when the sand which would otherwise be formed as cores, would be too weak to withstand the pressure of the metal. The construction of the pattern so that it would give the necessary impression for the internal shape must also be taken into consideration, as numerous joints would be essential in order to facilitate its removal from the sand. The additional joints and the cutting away of the pattern to make it a replica of the casting required would, in the majority of instances, render the pattern so flimsy that, if it were possible to obtain a mould, there would be considerable difficulty in its production. Not only would there be difficulty in manipulating the sand, but also in maintaining the correct positions of the various pattern sections, and afterwards, the various parts of the mould, so that the resultant casting would have that degree of accuracy which is obtainable from a more substantially constructed pattern, and which necessitates cores in the mould. The mould for a simple gland, for instance, as in Fig. 1, may be made without the aid of a separate core if the internal diameter is large enough compared to its length, and taper is given to the pattern so that it can be withdrawn easily without disturbing the sand. If, however, the diameter is small compared to its length, as in Fig. 2, it is difficult to withdraw the pattern, even though an excessive amount of taper may be allowed, without disturbing the central body of sand. Any light rapping which may be given to the pattern tends to break the connec-

tion of the central sand with the main body of the mould, and, in consequence, it is lifted with the pattern. There is no such difficulty when the pattern is only used to form the outside shape, and a loose body of sand or core is introduced for the central hole, as in Fig. 3, and moulds can be prepared more rapidly with less possibility of producing waster castings; also, incidentally, the holes are parallel, which is an economical consideration, seeing that it reduces the amount of metal machining. A more difficult example, although in principle similar, is illustrated by a mould for a valve in Fig. 4. It would be extremely impractical to attempt to make moulds from a pattern representing a model of the finished valve, however elaborately it may be jointed. From a solid pattern and core-box, however, the operation of preparing a mould is of a simple character, necessitating a single joint only, and the core can be accurately located when the pattern is withdrawn. Whether simple or intricate, the majority of castings require cores in the formation of their moulds in order to reduce the difficulties encountered in the manipulation of sand, and also in order to reduce the time expended in the preparation of one or many moulds, according to circumstances. When only one casting is required, its pattern may, in some instances, be a model of the casting, which may cause additional work in the foundry owing to the pattern leaving its own core, which would necessitate the adoption of some means of strengthening the central sand, and there would be the difficulty of obtaining a clean withdrawal. The additional work in the foundry, however, is more than compensated by the saving of a core-box in the pattern shop, but if many castings are required, it becomes a question whether the saving of time in the foundry if a pattern and core-box are supplied will be more economical. A simple illustration of this kind is shown in Fig. 5. For a one-off job the pattern can be quickly made similar to Fig. 6, a distance batten being dowelled on top, as shown, to ensure that the inside walls of metal will remain the correct distance apart when ramming. whereas should a number of castings be necessary, the pattern and core-box in Fig. 7 would be more economical, because little tooling, if any, would be necessary if the central shape of the bracket is cored out. This is an illustration of the advisability of using cores, not because they are essential, but in order to expedite the work when a number of castings are required.

Although the use of cores is cheaper when quantities of similar castings are required, in other instances cores may be used for a few patterns and a full pattern supplied for quantities. Thus the mould for a flywheel is frequently prepared in cores, the number depending upon the number of arms in the wheel. In such instances a block pattern may be used to give the external shape, but more frequently the shape is swept by means of a profiled edge board, and the cores are located in the impression, as shown in Fig. 8. If the wheel is of moderate size and many castings are required, it may be more economical to prepare a full pattern and dispense with cores, but with large wheels rarely indeed is more than one casting necessary for one size and shape of wheel, and the making of a full pattern would be an example of extravagance not usually associated with foundry work.

Other instances in which the use of cores make for economical production are illustrated in Figs. 9 and 10. The former shows a section of a mould for a rope pulley, the groove being cored out to facilitate moulding, whereas Fig. 10 is a section of a mould for a worm wheel, the teeth of which are sometimes formed by means of cores. In both these instances cores are used, not only to reduce the amount of jointing which would otherwise be necessary in the preparation of the moulds, but also to expedite production in the pattern shop. It is neither desirable nor necessary to make one full core to form the external shape, but a number of cores which when located in the mould will complete the full core. Thus, with the block pattern a sectional core-box is supplied, from which a definite number of cores will accurately form the full peripheral core.

In the preparation of larger and more complicated castings, cores are used to a considerable extent, not always because they are essential, but because the method increases the number of distinct operations; consequently more moulders can be employed, and the completed mould can be ready for casting in a shorter time than if many cores are dispensed with and the shape made in the mould. This, of course, does not necessarily mean that the production of the resulting casting will be cheaper, but that the time in which the casting can be delivered is reduced, a factor of importance when dealing with urgent work and in coping with increased business.

Green Sand Cores.

The same difficulties are experienced with green-sand cores as with green-sand moulds, but they are accentuated by the fact that cores mainly form the internal shape of a casting, and are therefore more or less enclosed in the molten metal when the job is cast. This undoubtedly increases the risk to which castings are exposed when green-sand cores are used, and the risk is increased according to the amount of surface in contact with the metal, and the reduction of outlet for the escape of steam and gases generated. Generally speaking, dry-sand cores are used when the risk of producing waster castings is greater than the saving of time obtained from the use of green-sand cores. This does not mean that there is no case for the green-sand core, but there are limitations to its usefulness. They can be profitably used in green-sand moulds of a repetition character when the area to be in contact with the metal leaves ample room for safe venting. In the making of aluminium castings they are frequently an advantage, providing free-venting is possible, because green-sand is a weak sand depending upon the moisture it contains for its cohesiveness to a considerable extent it is therefore likely to offer but slight resistance to the contracting metal This is an important consideration with aluminium, because of its high contraction and the low strength it possesses when hot.

Dry Sand Cores.

Cores are invariably dried, even though they may be required for a green-sand mould, and rarely, indeed, if ever are other than dried cores used for either dry-sand or loam-moulds. There is a greater safety attached to the use of a dry-sand core, and it can be handled more easily than a green-sand core.

Naturally-bonded sands are used to a considerable extent for the larger cores, many, in fact, being made of loam, the parts which are to form a surface for the metal being given a facing wash in order that a good skin will result on the casting; but it is important that the sand should peel from the casting, particularly from internal surfaces, and the application of blacking to core surfaces answers the purpose. Clay-bonded sands, however, become fairly hard when burnt through contact with the metal, and, not only is considerable difficulty experienced in removing sand so constituted from the internal parts of a casting, but it offers resistance to the contraction of the metal to such an extent that, unless special precautions are taken, the casting is fractured. When this is likely to be the case, with larger cores, it becomes almost imperative to use a sand which will become disintegrated under the heat of the metal, retaining its form and position only long enough for the metal to become solidified. For this purpose, carbonaceous substances are introduced as bonds instead of clay, or in addition to clay, which are burnt by the heat of the metal, and consequently the strength of the core is reduced, and it offers less resistance to the contraction of the casting.

Core Sand for Steel Castings.

The best of materials are necessary for this class of work. Steel moulders' "compo" is used to a considerable extent, particularly for large cores, because if its heat-resisting qualities; it, however, forms an exceedingly strong core, and, although the strength of the core sand in which it is introduced is varied to suit the work to be cast, for many classes of work, especially medium or small complicated castings, it is nevertheless unsuitable, being liable either to cause shrinkage cracks or unnecessary labour in fettling. For other than very large work, silica sand or sand such as the "Yorkshire" variety, which is comparatively free

from fusible impurities, is used. The silica sand used must be of a high grade, and, although china clay is more frequently used as a bond, sawdust is usually added also. Sometimes the cores made from the mixture are dried until the sawdust is partially charred, in order that they will be more readily crushed by the casting, but the heat of the metal is such that a considerable charring action is effected in any case, and the core is more easily removed from the cooled casting. Both flour and molasses, in combination, and flour alone, are sometimes used as bonds, although not very frequently. Cores so constituted require to be well supported, as the bond is partially destroyed during drying and the cores are more or less rotten. Silica paint should be applied to cores having the bonds mentioned, to give a strong face to the cores. Glutrin can be used with success as a bond for core sands to be used for intricate work; it is, however, very necessary to watch the temperature of the drying oven. In this case the bond sweats, it being drawn to the outside of the core by the heat, and a hard surface is produced, while the centre of the core is rotten. Should this outer skin be broken, the central sand will run out. This difficulty is somewhat obviated by using clay in conjunction with glutrin in the core mixture.

Core Sand for Aluminium Castings.

The temperature of molten aluminium is comparatively low; its strength when hot is also very low, and, coupled with this is the high-contraction factor of the metal; it is very important, therefore, that these be considered when the composition of the core mixture is in question. The more the core is surrounded with metal, the greater the care necessary in the selection of a suitable bond. A mixture may be used which gives a hard skin to the core when it is dried, and leaves a soft interior, then the soft interior of the core allows it to crush, and as the outside is disintegrated by the heat of the metal, there is no difficulty in removing the core from the casting. On the other hand, a bond may be used which softens by the heat of the metal, although maintaining the shape of the core until the metal has set. The softened core offers little resistance to the contraction of the casting, it being distorted readily by the gradual changing shape of the casting. Resin is the bond which fulfils this latter requirement, but when used the cores should be removed from their castings while they are warm, otherwise the resin which has not carbonised will again cause the central sand to become hard, which increases the time expended in fettling. Commercial core gum is frequently employed as a bond for the core sand from which the cores for aluminium are made, and, with care in the preparation of the mixture to suit the quality of sand used and the character of the work for which the cores are required, it gives successful results.

Core Sand for Brasses and Bronzes.

Core sand suitable for the common brasses varies considerably. In many instances the ordinary clay-bonded sands, prepared in suitable proportions from Birmingham Red or Mansfield Sands, are suitable for the purpose without artificial bonding. These mixtures are also applicable to the bronzes, which, by the way, need a close surface because of the searching character of the metal, but, although naturally-bonded sands are used, particularly for large cores and general work in jobbing foundries, the value of artificial bonds is unquestionably generally recognised, especially in foundries dealing with repetition work. For castings in these alloys it is not so much because of the contraction difficulty that artificial bonds are desirable, but because the time of cleaning them is minimised. Flour is frequently used as a bond, mixed in various proportions according to the strength desirable, or in some instances it is preferred to make flour starch, and use it for tempering the core sand. With the latter, sawdust is invariably introduced to open the texture, Molasses, too, is sometimes used to supply the necessary bond, but core mixtures containing this ingredient should be freshly prepared, as molasses water ferments if allowed to stand a day or two, and its bonding quality is diminished. It is therefore not a dependable bond. Dextrine or core gum as a bond gives quite successful results, and is prepared in many foundries, although care is necessary in drying the cores when this bond is used, otherwise they become fragile.

Core Sand for Cast Iron.

As with the brasses and bronzes, a wide variety of materials can be used to give the necessary bond for core sands for cast iron, the choice depending upon the work to be done. Thus, for intricate cores which must be strong and yet free-venting, oil-bonded sands are superior to other known artificial bonds. Oil sand cores have a distinct advantage in that they do not absorb moisture readily after they have been dried, an important consideration when they are used in green-sand moulds. Strengthening irons, such as would be necessary in a core composed of clay-bonded sand, are in many cases unnecessary, or almost entirely eliminated with oil-sand. Linseed oil is undoubtedly the best oil for the purpose, and many of the core oils and oil compounds have this oil as a base, other oils being introduced in the compounds with the idea of cheapening the bond rather than increasing its strength. Some of the blended oils resemble paint oils in that they carry resin, and although the oils themselves may have little bonding quality, they serve as carriers for the resin and form a more or less waterproof core. Although artificial bonds have come into prominence to a greater extent during recent years, particularly for core-sand mixtures, the clay-bonded sands will never be totally eliminated. Clay-bonded mixtures are cheaper when used for large cores, and the cost of bonded strength is undoubtedly a guiding factor. It is, of course, necessary to take the long view when deliberating the cost, and consider not only the first cost of the material, but also the additional cost of grids, plates, or irons which may be necessary for support, any difference in time occupied in preparing the core, the quality of surface on the finished core, the facility with which it vents, and the relative ease by which it leaves the finished casting. When the castings to be made are of a repetition character, artificially-bonded sands are cheaper, because all the facilities are in favour of repetition, and mixtures can be economically prepared to suit the work, the smaller and more intricate cores needing a stronger bonded sand, whereas the larger cores, because of their bulk which assists the core in maintaining its shape, need less bond. In the making of large castings core-loam is not likely to be displaced, as it is readily prepared, and it can be used with all forms of core-boxes, supplied to jobbing foundries.

No effort has been made to give definite mixtures for core sand, as we believe a mixture conveys little to the reader unless he is likely to use similar sand for similar work. This is one special sphere in which experimental work is of first importance, and while facilities are not usually available in foundries, those students who are alive to the necessities of progress, and who attend the many foundry classes which are now organised, would do well to consider this subject particularly. There are some general considerations which can be given here relative to artificially-bonded sands. It is better, for instance, that the sands used should be as free as possible from clayey matter, such as are known as weak sands, and invariably it is desirable that they should be dry when the bond is added, as this gives a better chance of more thorough mixing, and, incidentally, a more regular composition can be assured, because the amount of moisture a damp sand contains is an unknown quantity. When possible, the bond should be mixed with water to be used for tempering the sand; in the case of oil it should be emulsified with water, in order that it may be carried to every particle of sand. Core-sand should be specially ground or thoroughly mixed by mechanical means, to ensure thorough incorporation of the bond with the sand. With clay-bonded sands or loam core mixtures and other carbonaceous materials, besides sawdust, which are frequently added, are cow hair and chopped straw, both of which act as bonds as well as openers, and coke breeze ground with the mixture opens the texture of an otherwise close and strong sand, and is, as a rule, more effective than either sharp or sea-sand for the purpose, although the latter may be added to reduce strength when the texture is sufficiently open for venting.

The Influence of Phosphorus on Brass.*

By A. Portevin.

A French writer has recently made a number of experiments to show the effect of various proportions of phosphorus on brass. Two series of brasses were made with an increasing proportion of phosphorus, added in the form of phosphor-copper containing 10 per cent. The first series averaged 68 per cent. copper and the second 58 per cent. Tests were made from both series cast in sand and in chills, the latter being in the form of round bars 45 mm. (1¾ in.) dia. Each test piece was analysed, tested for tensile, hardness and impact.

Since the results of mechanical tests on cast alloys are subject to a number of factors, they must be considered as a whole rather than as representing great accuracy individually.

Table I.—*Brass Cast in Sand.*

Chemical composition of all the brasses. Pb.=O. Sn.=O, or traces.			Tensile test.				Hardness. Ball 10 mm. dia. under		Impact on notched bar.	Hardness. "Shore."
Cu. %	Fe. %	P. %	Ult. Tons sq. in.	Elastic limit. Tons sq. in.	Reduction of area. %	Elongation. %	2,200 lbs.	1,100 lbs.	Kgr. m. per sq.c.m.	
68.94	0.06	0.000	6.8	2.9	20.0	20.5	—	25	12.0	11.00
69.15	0.07	0.029	7.6	4.3	25.5	21.8	—	29	12.0	10.25
68.79	0.06	0.077	5.6	3.0	12.0	20.5	—	28	10.8	11.00
68.17	0.16	0.51	4.8	4.4	4.0	7.0	—	32	2.5	19.00
67.10	0.06	0.66	8.0	0.14	7.0	8.4	42	—	1.6	19.00
66.65	0.07	1.47	8.5	6.80	2.5	0.0	55	—	1.2	21.00
2nd series averaging 58% copper.										
59.01	0.10	0.00	22.2	5.40	44.0	41.0	74	—	16.0	21.75
59.29	0.15	0.20	22.4	8.10	36.0	43.2	61	—	11.5	21.50
58.93	0.07	0.07	21.8	8.25	33.0	39.8	60	—	11.3	22.50
58.65	0.22	0.48	Snapped when tightening machine.				65	—	3.6	21.25
57.83	0.05	0.64					73	—	1.3	22.00
57.08	0.11	1.19	9.5	9.5	1.0	0.0	83	—	1.1	29.75

Table II.—*Brass Cast in Chills.*

Chemical composition. Zn. used was free from Bi. and Sb. As. = 0.015%.						Tensile test.				Hardness, ball under	Impact, notched bar.
Cu. %	Pb. %	Sn. %	Zn. %	Fe. %	P. %	Ult. Tons sq. in.	Elastic limit. Tons sq.in.	Reduction of area %	Elongation. %	Lbs. 4.400	Kgr. m. per sq.c.m.
1st series averaging 68 % copper.											
68.57	0.74	traces	30.53	0.13	0.000	—	—	—	—	54	7.20
69.47	0.63	—	29.37	0.45	0.033	10.2	7.0	11.0	18.0	64	10.6
69.56	0.49	—	29.60	0.25	0.071	12.3	6.3	18.0	24.0	64	8.1
68.62	0.58	0.08	30.13	0.15	0.38	—	—	—	—	74	4.0
69.25	0.44	0.16	29.20	0.22	0.69	13.2	7.7	7.0	8.0	82	1.75
68.12	traces	0.13	30.07	0.24	1.38	—	—	—	—	95	1.55
2nd series, averaging 58 % copper.											
59.53	traces	traces	40.33	0.09	traces	25.2	9.1	39.0	39.0	93	7.5
61.14	—	—	38.48	0.29	0.046	23.0	8.3	40.0	39.0	80	11.8
60.47	—	—	39.27	0.18	0.059	22.6	9.4	26.0	33.0	86	10.1
58.76	—	—	40.77	0.07	0.38	—	—	—	—	121	1.25
58.16	—	0.03	40.87	traces	0.86	4.5	4.5	00.0	00.0	128	1.25
57.08	—	0.05	40.94	0.12	1.73	—	—	—	—	141	1.25

From an examination of Tables 1 and 2, it will be seen that the mechanical properties are not sensibly affected so long as the phosphorus content remains below 0.05 per cent. When the proportion of phosphorus exceeds 0.5 per cent., a rapid fall in ductility and elongation takes place. The metal becomes brittle as the hardness increases. The great fall in ductility shows how entirely fallacious are the ultimate tensile strength and the apparent elastic limit when considered alone.

These tests have clearly demonstrated the danger of considering mechanical tests from the point of a few figures only. They also show the great differences resulting from the rate of cooling, and how useless it is to consider the results furnished by test-pieces that have been cast separately as indicating the quality of a casting.

The presence of phosphorus in these brasses is casual, not intentional, since it does not play the part of a deoxidiser, that function being carried out by the zinc. In conclusion, it can be stated that the presence of phosphorus to the extent of 0.05 per cent. is not harmful to brasses of the quality stated.

* Extracted from a Paper presented to the Nancy Congress before the Association Technique de Fonderie.

Complimentary Dinner to McLain.

A complimentary dinner was given to Mr. David McLain on his returning to America at the Central Station Hotel, Glasgow, on Oct. 13.

The Chairman, Mr. John Cameron, was most eloquent in his praise of the McLain system, and from his own experience he advised everyone connected with the ironfounding trade to take the McLain course of lessons.

In his reply Mr. McLain expressed his heartfelt thanks at the very great honour the McLain students had done him that evening. He was going home with most pleasant memories of his stay in this country, and hoped to return again next spring.

The toast of "The Foundry Trades" was proposed by Mr. James K. Shanks, to which Baillie John King replied. Mr. Walter Mitchell proposed the toast of the McLain Students, which was replied to by Mr. Geo. Albert Ure.

The musical programme was in the hands of Mr. John More, Mr. William Shanks, and Mr. John Wright.

Amongst those present were Messrs. Matt. Riddel, Past-President, Institution of British Foundrymen; Donald M. King, T. P. Cameron, Hugh M. Hodgart (President, Scottish Branch of the Institution), and Professor Campion.

It was announced during the evening that Messrs. Grimes, More & Company, of 11, Bothwell Street, Glasgow, had been appointed agents in Scotland for Mr. David McLain.

Institution of British Foundrymen.

BIRMINGHAM BRANCH.

The opening meeting of the session took place at the Municipal Technical School, Birmingham, on October 14, when the President (Mr. W. J. Flavell) delivered his address.

Mr. H. Field said it was their good fortune that night to have present Mr. H. L. Reason, who was not only a past President of the Branch, but the President of the Institution, and he thought it was only fitting that Mr. Reason should take the chair.

The Secretary (Mr. D. Wilkinson), having read the minutes of the annual meeting, which were approved, announced apologies for absence from Professor Turner, and Messrs. R. Buchanan, Ball and Winterton.

In inviting Mr. Flavell to deliver his address, Mr. Reason spoke in appreciation of his valuable work for the Birmingham Branch. Mr. Flavell, he said, had been regular in his attendance at Council meetings, and he had always regarded him as one of the stalwarts of the Branch.

Presidential Address.

Mr. Flavell, who was very warmly received, then gave his address:—

Gentlemen,—Last session was one which I can speak of with a great amount of satisfaction, for it marked an epoch in the history of the Institution of British Foundrymen, which we are not likely soon to forget. I refer to the Exhibition and Competitions in Bingley Hall. Speaking proudly, it was in every way a magnificent success, and reflected great credit on all who had the arrangement of the work. Members of the various Branches expressed repeatedly their pleasure at being amongst us, and desired in every way to show their appreciation of all that was done to make their visit happy and enjoyable.

It is also with feelings of pleasure that I call to your notice the signal honour that has been conferred on this Branch by electing on of the members, Mr. Reason, to fulfil the office of President for the ensuing year. Those of us who know him are fully aware that he will preside over the affairs of the Institution with moderation and wisdom.

With reference to the coming Session, I should have had greater pleasure on this occasion if trade were good, but it does seem as though there is a slight tendency for better times for all. There is undoubtedly an increase in the amount of inquiries which are being made in connection with the foundry trade generally. To speak more closely of the work of our Branch we are, as all are aware, the nucleus of the Institution. It was initiated in Birmingham, and it must be a great source of satisfaction to those, some who are still, among us, to see how the Society has grown in volume and usefulness.

Local Foundry History.

Within a few miles radius, some of the first great historical events took place, as for centuries past the foundry trade has been in existence round about us, some of our foundries and blast furnaces dating back 200 years. The work that was done in those early days is still in existence, not only in our immediate neighbourhood, but all over the world. It is rather surprising that a comparatively small town like Wednesbury should be, without doubt, the "Mother of the Midlands." This town was erected by the Founders of Mercia, in A.D. 577, which, at that early date, enjoyed a civic status and possessed burghal government. As a burghal centre, it is older than the county town of Stafford or the City of Lichfield.

There is no doubt that the destiny of these Midland towns was irrevocably settled at the Creation, the masses of useful mineral wealth which nature deposited close beneath the surface, pre-ordained it to become in the evolution of human civilisation, what in the parlance of the practical language of to-day is called the coal and iron district. In my own recollection, little more than a scratch on the surface revealed rich stores of that most useful of all minerals, and lying close beside it the fuel wherewith to smelt it, and even the lime to flux it in the furnace.

Before the year 1500 coal was being dug in the neighbourhood, though its utility, when chimneys were unknown, was at first scarcely recognised. Two centuries elapsed before the immense usefulness of this mineral was fully recognised. In Elizabeth's reign the tenants of the surrounding small hamlets were going to the High Court of Chancery to establish their right to dig coals for their own use. The use of coal was supplied first of all to domestic purposes, but the extension of its use to the working of iron and other metals followed soon afterwards. As in the reign of James I., it was being burnt on hundreds of smith's hearths all around the district known as the Black Country. But the great problem of two centuries which still remained unsolved, notwithstanding repeated experiments, was the use of mineral coal for smelting the iron ore in the furnace. Of the experiments of Dud Dudley, at Sedgley, about 1620, it would be superfluous to speak here, but a Wednesbury experiment may prove of interest.

In 1675 Frederick de Blewstone, a German inventor, came to Wednesbury and erected a furnace, in which only the flame of a coal fire came in contact with the iron ore. It ended in failure, and although the principal was right, it seems to have been the inability to produce sufficient blast to ensure the complete combustion of the coal. It was repeatedly proved how inadequate it is to blow a coal-fired smelting-furnace with leather bellows worked by oxen or horses, or even by human labour, which was sometimes employed.

We now know that what the manufacturer was really waiting for was a power greater than any animal power could supply. In 1781 James Watt completed the invention of the steam engine at Soho, and at Bradley, near Bilston, in 1785, John Wilkinson first applied a steam-engine to blow a blast furnace. Bradley Furnace was therefore rightly named the "Mother of the Black Country Furnaces." From this period onwards this district began to assume more and more importance in the march of industrialism.

No pen can describe the aspect of the early Victorian Black Country as that of Charles Dickens has done. During the cholera visitation in 1832, the great novelist passed through on a coach, and he afterwards recalled his impressions in the "Old Curiosity Shop" in describing the wanderings of those immortal characters, Little Nell and her Grandfather.

After 1785, when blast furnaces were springing up, the foundry trade began in the Midlands to assume the proportions as it is to-day. Many and various have been the alterations and improvements since those early days. Its pioneers have all passed away, and foundrymen are expected to carry on and improve upon the work which they started, and there exists no better means for mutually assisting that trade than the Institute of British Foundrymen. Its programme is almost never ending, for it deals at various times and places with every conceivable subject in the foundry industry. Its work is purely voluntary, and is given for the benefit of everyone of its members.

The Institution and the Pattern-Maker.

This address is to be followed by a discussion, but up to now little has been said which is debatable, but there is one item to which I should like to give expression, and that is, how does the Institution help the patternmaker? Sometimes we forget what an important part he takes in the foundry trade, and his position does not give opportunities for the reading of Papers, and this is quite a mistake. How can we adapt ourselves to give to the patternmaking branch of the foundry trade more inducement to join us and so increase our membership and usefulness? We are living in a time when all the experience and knowledge that can be acquired will be necessary for the coming generation, if they are to keep up with the pace of competition all over the world. If the pattern-

maker is a man who is content to work at the bench all his life, there is little to be said, but if he has ambition and wishes to attain to any position of eminence, he must not only be able to use his tools, but he must extend his studies and knowledge until he has made himself conversant with foundry practice generally. I have known many men of this class, and some have been of the highest type of foundry men. The same remarks apply to the moulder. Should he determine to get along he must not only study how to make a mould satisfactorily, he must also have a good knowledge of metallurgy and chemistry. He must know how a certain thing is done and why it is done to get the results desired. Chemical analysis is excellent for a man to understand, but there is a great deal in this which can be very often misleading. There is that practical knowledge gained by close study, which is only attained by hard work and experience, to produce in the casting what he has found in the pig before smelting. What our object is is obvious. It is to give by papers and discussions something which our members may not have possessed.

Vote of Thanks.

In proposing a vote of thanks to the Branch-President for his Address, Mr. Reason said they were very fortunate in having as President a practical man who had served his time and understood the wants of the industry. He had given them a review of the ironfounding industry in the Midlands, and it was interesting to hear what an important position was held by Wednesbury in the industrial development of the district, although it had been surpassed to-day by the great manufacturing centres close at hand.

Mr. J. B. Johnson, in seconding, said he had known Mr. Flavell as a workman, as a trades unionist, and as a close personal friend. They had had many able presidents in the past, but he was confident Mr. Flavell would fill the position equally as well as any of his predecessors.

The motion was enthusiastically endorsed by the meeting.

DISCUSSION.

Mr. Reason said the President had raised the question as to how they could encourage pattern-makers to take more interest in the Institution, and he had also said that if the moulders of to-day were ambitious and wanted to go forward they could not do better than join the Institution and take part in its work. He could not say what was the percentage of patternmakers in the Institution, but it was quite a respectable number. In fact, he might say that the principals and foremen and managers of the largest engineering concerns in the country, and the foremen of the different pattern shops, were members of the Institution, and realised that their membership was necessary if they were to keep abreast with modern methods. With reference to moulders or other foundry workers wishing to improve their position in the industry, he admitted that there was this difficulty, that after a full day of hard and laborious work a man had little energy left for attending evening classes, and when Saturday afternoon came he looked forward to recreation rather than to further work. It spoke volumes for the men who, after a hard day's work, took up studies in the evening and also attended the Institution meetings on Saturdays. He often marvelled at the attendance they had at their meetings, for it could be considered as a prolongation of working hours. But he ventured to say that once they crossed the threshold, attended the meetings and secured some enlightenment on the technical side of the industry, what might look like work at first sight would be transformed into recreation. When he (Mr. Reason) first attended the meetings of the Branch many years ago he came with a certain amount of diffidence, but to attend a meeting of foundrymen to-day afforded him as much enjoyment as going to a place of amusement. Indeed, if he missed a discussion he felt he had missed something which he might perhaps never have an opportunity of recapturing, because no matter what the subject was that was under consideration they were always likely to learn something.

Parochial Outlook.

Mr. H. Field emphasised the value of the Branch meetings from the point of view of gaining by other people's experiences. Men in the pattern shop of a foundry, for example, were inclined to follow their own methods without going outside and learning from more advanced methods, perhaps, elsewhere. They might be far behind the times without being conscious of it, and if they came and saw what other people were doing it might stir them up. Mr. Flavell had referred to Wednesbury and its apparent pre-ordination to be one of the centres of the manufacture of iron. In his opinion the pre-eminence of the Black Country in that respect was fast passing away. He did not think any new iron and steel plants would be erected in the district. The puddling industry was rapidly disappearing. The furnaces here were not so up-to-date as in other districts. He thought the district was destined to become a manufacturing district, such as Birmingham, and not a district for the production of the raw materials of engineering.

Replying to Mr. Field's point as to the future of the puddling industry in the Black Country, Mr. Flavell admitted that it was undoubtedly on the decline, but said the explanation was that steel was taking its place. Steel was brought into the Black Country from various centres in the form of billets cut off into lengths and rolled down, and was taking the place of the old puddled wrought iron in a great many cases.

Necessity for Co-operation.

Mr. A. Wardle spoke of the lamentable lack of co-ordination between the various departments in foundries, and laid stress upon the importance of seeing the other man's point of view. The moulder often objected that a pattern submitted to him was not a practical thing to make, but if it became practicable to make it the draughtsman and the engineering industry would have more scope. At present designs, particularly of automobile work, were only limited by what it was possible to get made. In many cases they found draughtsmen, through ignorance, putting designs on paper where the same result could have been obtained by simpler means, from the standpoint of the moulder. He thought the Society might be the means of helping to eliminate misunderstanding and the want of co-ordination which at present existed.

Lack of Education.

Mr. A. Parsons expressed the opinion that the smelting of iron ore was largely due to the pioneer work of Dudley, and to-day, he said, they were reaping the benefit in having such a wide range of selection of materials for foundry work. Since the close of the last session he had canvassed the foundries of which he was foreman, and he found a spirit of indifference among the moulders with regard to the Institution and its work. He had described to them the work done by the Institution for the uplifting of the moulder, and the invariable reply he got was that " They cannot tell me anything that will do me any good." He thought they were wrong in their attitude, but how was it possible to demonstrate to them that by means of the Institution they would get information which would help them along on the technical side particularly, and give them a broader outlook on their work? Of course, they got practical knowledge in the foundry, but the majority appeared to think that there was no technical side. The moulder was content with methods which enabled his predecessor to turn out a good job, and was rather reluctant to have new ideas put to him. In his opinion, the employer was more responsible than anybody else for that point of view on the part of the practical moulder. He did not think employers gave them sufficient encouragement. The moulder had his job to do, and the employer wanted him to see it through, and had no inclination to let him spend part of his time with the foreman or anyone else who could give him some information on the job in hand. It was because no one took a keen interest in the moulder on the technical side of his job that the moulder was indifferent when an appeal was made to him to join such an Institution as theirs. Prob-

ably the same reason accounted for the apathy of other branches of the trade.

Narrow Outlook of Foundrymen.

Mr. E. H. Tyson agreed that it was a difficult matter to persuade either patternmakers or moulders to come to those meetings. Many of the men did not take sufficient interest in their work to be willing to sacrifice time and effort in order to make progress. Their feeling with regard to a job was "If it is a good one, all well and good; if it is a waster we will make another." They would risk a scrap casting rather than make sure of getting a good one. Nevertheless there had been a big advance in the foundry trade. When he was patternmaking in Coventry about 25 years ago he took a water-cooled cylinder to a foundry. It was the first one he ever made. When the foreman saw it he said, "What do you take moulders for?" "Do you think a moulder can make a thing like that?" To-day it would have been a simple job in a foundry, but the firm in question would not have anything to do with it. The result was that he had to take it to another foundry, where they managed to get a good casting.

The Future of the Black Country.

Mr. D. Wilkinson insisted upon the importance of taking a broad view of their work, realising how intimate was the relationship of their particular job with other people's work, and that each man contributed something to the sum total. They ought to look upon their work, he said, as being allied with the advancement and uplifting of humanity. If they took such a view as that they would cease to be interested merely in their own little affairs. They frequently found when a pattern came into the shop that it could have been treated in such a manner as to have saved a large amount of trouble and effort in forming the mould, without any additional cost or labour in the pattern shop. Similarly, if the moulder took a broader view of his work he would be less carpingly critical of the quality of patterns sent to him. If patternmakers realised that their work was not finished when the pattern went out of the shop, but that it had only then really begun, they would take more interest in foundry work. He had been told by several patternmakers that when they came to be attached to a pattern shop connected with a foundry they had been surprised at the improvement they could make without any additional cost. There was nothing like broadening one's point of view to enhance one's value. The great thing that was holding back engineering was the want of co-ordination and of mutual appreciation and assistance in tackling problems. If there was mutual understanding and help before money was spent, economies could be effected, and there was no doubt that unless economies were effected trade could not improve and prosper. He did not agree that the Black Country was in any degree played out. When they remembered that in America ores were transported a matter of a thousand miles or more it widened their view of how the trade of the Black Country might be maintained and improved. He thought he was right in saying that so far as the manufacture of iron was concerned, and especially puddled iron, one of the largest manufactories of puddled iron in the world was at present in the Black Country. It was certain that if the men in this neighbourhood would cultivate the habit of looking at things from a broad point of view and get over their little parochial attitude, a fresh era of prosperity would open out before us.

Draughtsman Controlling Factor.

Mr. F. C. Edwards thought that if the men could be once got to attend a meeting it would be possible to hold them. The difficulty was to get them to break the ice. The draughtsman was the controlling factor in the situation, and very often through ignorance he placed more on the moulder than the latter could bear. He thought it would be a good thing if patternmakers could spend six months in the foundry.

Mr. Reason thought that if they could get a good attendance of men from the foundries it might be possible to stimulate their interest by the cinematograph or lantern slides showing various processes. He added that last year a number of vacancies were filled by people writing to the Institution when they wanted men, and in his opinion that was a movement which was bound to grow. It will readily be appreciated how this enhances the value of the Institution.

The Author's Reply.

Replying at the close of the discussion, the President said many of the observations made were interesting. Mr. Wilkinson had spoken about breadth of view, and he agreed that it would be most valuable if they could induce the men in the works to look with anything like breadth of view upon their occupation. It was difficult, however, because with the march of commercialism trade had become more monotonous. More machinery was used, and no great demand was made upon individual intelligence. A man's movements were to a large extent automatic; he did one little part of a job and that was all he had to do with it. To get the breadth of view of a millwright, for example, in the old days was now very difficult indeed. He felt that if they could get the patternmaker and the journeyman moulder to become members of the Institution it would broaden their knowledge; they could obtain information that they perhaps lacked, and do themselves good and do the Society good at the same time.

WEST RIDING OF YORKSHIRE BRANCH.

At a meeting held on October 14 in the chemistry theatre of the Bradford Technical College, Mr. A. A. Liardet, Branch-President, in the chair, Mr. Oliver Stubbs, a past-president of the Institution, gave an address on "Impressions of the American Iron Foundry Business." More than forty members were present, which, taking into consideration the recent formation of the Branch, is distinctly encouraging.

Sheffield Foundry Trades Technical Society.

Before introducing his subject, Mr. Stubbs commented on the formation of a foundry technical society at Sheffield, where a strong branch of the Institution has been in existence for fourteen or more years, stating that such a society was quite unnecessary. It was a pity such a society had been formed, and it was to be hoped that no members would be enticed away from the national organisation.

AMERICAN IMPRESSIONS.

Before stating his actual impressions, the lecturer pointed out that at the time of his visit (April, May, and June last year) trade was just beginning to pick up, some of the foundries having been shut down from twelve to eighteen months. The largest foundries are those associated with the automobile industry. General foundry business was fairly good, but the malleable trade had not then recovered from the depression.

The two outstanding features of American foundry practice which cannot fail to impress any Britisher are the class of labour employed and the systems of transporting materials inside foundries.

With regard to the former, it should be pointed out that every nationality is to found working in foundries, with a distinct preponderance of the black element, especially on moulding machines. During the recent war the coloured population made immense progress. There are specially large quarters to be found in the large cities where the population is entirely black. There are other distinct sections favoured by the Irish, German, Jewish, and Latin elements. This necessitates an organisation in works totally different from anything in this country. In some cases workpeople are totally unable to converse with each other. Notices have to be exhibited in a dozen or more languages. Obviously such a heterogeneous collection, when once initiated into their work, makes for production, as their principal object in life is to earn the maximum amount of money that can possibly be obtained from their piece-work system

Transport.

With regard to transport, the Americans can teach us much. They have so designed their shops that the material is transported overhead by means of electrical travelling cranes, monorails, conveyors, or other systems, allowing of the maximum use of floor space. Obviously the first essential for such systems is good buildings, and it can safely be stated that the majority are good. Here and there, however, especially amongst the jobbing foundries, there still remain some poor old-fashioned shops. A factor which may have contributed to this extensive use of conveying units is the American law which prohibits women from carrying more than 18 lbs.

Malleable Industry.

Perhaps no metallurgical industry in recent times has gained more from technical research than the malleable-iron industry of America. For instance, the National Malleable Foundries of Cleveland turn out some 2,000 tons per week. To accomplish this a continuous annealing process has been satisfactorily established. The core making is quite mechanical and standardised. The various sands and oil are measured out in definite quantities and automatically mixed. The mixture is conveyed to women operating handy machines. The cores are in turn conveyed into the drying stoves, which are continuous, and when dried conveyed to the moulders, special precautions being taken to prevent any jarring.

Pig Iron.

Pig iron is practically always machine cast. The benefits to be derived from this were outstanding in Great Britain, when during the war not merely was sand adhering to the iron but even fair-sized pebbles. This is a subject which requires energetic study and action by British foundrymen. The pig, on arrival at the works, is handled by cranes with magnet attachments. It is weighed in special trucks and conveyed direct to the furnace platform, or in many cases the cupola itself. This latter method is adopted at the International Harvester Company of Chicago, where special attention is paid to both weighing and chemical analysis. The metal leaving the cupola is likewise weighed by the insertion of spring weighing machines, being the crane hook and ladle. Additionally, charts are prepared and exhibited in the foundry indicating the tendency of the silicon, manganese, sulphur, etc., to rise or fall. Another chart gives the daily amount of wasters, which are carefully investigated, and the reasons for the defect is ascertained, assigned, and if possible remedied.

Core Making.

Perhaps the most interesting core-making machine seen by the lecturer was one designed by an engineer associated with the Westinghouse Brake Company. At the time of the visit it was engaged upon 4-in. stop-valve body cores. The top half of the box had holes drilled through it, by means of which the core was rammed entirely pneumatically. Of course, this was more or less of a novelty, the core- and mould-making machines which are most used are the Pridmore, Tabor, and other makes quite well known here. The tendency with moulding machines is to install electrically-operated compressed air machines. Female labour is extensively employed in the core shops. The blacking most extensively used in the States, both for moulds and cores, appears to be a mixture of ½ machine oil, ½ petrol, ½ plumbago. It is applied by means of a spray instead of by a brush.

Speed Limit.

At the Westinghouse Brake Company's Works Mr. Stubbs was informed that a moulder is using the same sand every 35 mins. The moulds work on island turntables. The system being that one man does a definite job, and that finished, the table turns, putting the box before another operator, who carried the work a little further. Very shortly it comes into the teeming position. After casting it is taken to a bumping grid, where the sand falls into a cellar; the casting is conveyed to the fitting shop, and the box back to No. 1 operator. The sand is conveyed to the sand preparing plant, where definite quantities of new material are added and mixed. The sand is then taken by bucket and overhead conveyors to a chute situated above the turntable.

It is impossible to overstate the care bestowed upon the patterns utilised for this mass production. Before sending a pattern to the foundry, it first goes to an experimental foundry, where it is thoroughly tried out.

A Cylinder Testing Economy.

Obviously, in works of the magnitude of the Ford Works, a considerable power is daily generated in the testing of automobile cylinders. This it not allowed to be dissipated, but is utilised for the production of power by means of small dynamos.

An interesting job made on a moulding and noted by the author was a carding cylinder, 40 in. long and 50 in. diam. It weighed 1,200 lb. The jarring machine used rested on concrete foundations, weighing 120 tons, but in spite of this considerable vibration was experienced. All such machines as this are provided with a sand chute, placed conveniently for filling the box. Of the pattern in question four men made eight castings per day, and the price charged to the machine shop was 3 dollars (13s. 5½d.) per cwt.

Welfare Work.

During and since the war the Americans have made tremendous progress in welfare work, which extends to the home of the worker. The works are well provided with modern lavatories, bath rooms and mess rooms. Baths and washing are carried out in the workman's own time, and as far as the lecturer could judge, the washing facilities were not rendered inoperative through the misuse of tea leaves. In the cafeterias—mess-rooms—concerts and lectures are provided during the lunch hour, some of these having wireless installations for this purpose.

Fettling Departments.

These he found to be conducted on the best lines, so far as transport and hygiene were concerned. Extensive use is made of the excellent systems of sand blasting apparati in vogue there.

Finally it should be emphasised that in the States full recognition is given to the foundryman as a high-class specialised worker.

Votes of Thanks.

The Branch-President, in calling upon Mr. V. C. Faulkner, the Editor of The Foundry Trade Journal, to propose a vote of thanks confirmed the lecturer's impressions as to the heterogeneity of the labour employed and to the excellence of the American systems of handling material.

Mr. Faulkner, in proposing a vote of thanks to the lecturer, said that British foundrymen had much to learn from American practice. He also was of opinion that much benefit could also be derived from a study of Continental conditions, a matter which was much more easy for the majority of the members. Next autumn an International Foundrymen's Congress and Exhibition is being held at Paris. Members had been invited by the Association Technique de Fonderie, but the Council of the Institution had decided against holding their Congress there. However, The Foundry Trade Journal would consider organising a visit to France should a definite desire be found to exist amongst foundrymen. He had great pleasure in proposing a hearty vote of thanks to Mr. Stubbs for his most enjoyable lecture.

Mr. J. Robinson seconded this, pointing out the valuable work which Mr. Stubbs had done for the Institution during his short term as President, and was happy in the knowledge that he was to take office again next year. The vote was carried with acclamation.

Mr. Stubbs in acknowledging, stated that it was one of the happiest years in his life, and whilst he looked forward to another year in office, they must not expect anything on so pretentious a scale as the Birmingham conference.

The remainder of the evening was devoted to an appeal by Prof. Charnock for the support of local foundrymen in the conduct of his apprenticeship classes, and discussions on "Scientific Cupola Practice" and "Impurities in Cast Iron."

The British Cast Iron Research Association.

Appointment of Director of Research.

The Council of the British Cast-Iron Research Association have offered the important position of Director of Research to the Association to Dr. Percy Longmuir, M.B.E., of Sheffield, which he has accepted. He will take up his duties on November 1.

Dr. Longmuir is one of the foremost recognised experts in cast iron, and the appointment is of the greatest importance not only to the ironfounding industry all over the country, but to the engineering and allied trades. His connection with the industry dates from 1897, and his career as foundry apprentice, foreman, manager, and finally as director, shows that he has passed through all the necessary practical stages. His metallurgical training was received under Professor Arnold at the Sheffield University, after which, in May, 1902, he was awarded a Carnegie Research Scholarship by the Iron and Steel Institute, and this was renewed in 1903, culminating in the receipt of the Carnegie Special Medal for his Research on "The Influence of Varying Casting Temperature on the Properties of Alloys" and

Dr. Percy Longmuir, the newly-appointed Director of Research to the B.C.I.R.A.

on "The Properties of Iron and Steel Castings." This research work was followed by a further period of research work at the National Physical Laboratory. The result of this work, in collaboration with Sir Robert Hadfield and Professor Carpenter, was published in the report of the Alloys Research Committee of the Institution of Mechanical Engineers.

Upon leaving the National Physical Laboratory to take up foundry consultant work at Sheffield, Dr. Longmuir was one of the first external examiners in metallurgy appointed for the Sheffield University. From 1909 to 1919 he held the post of works manager at the Stocksbridge works of Messrs. S. Fox & Company, Limited, and is at present the Technical Director to Messrs. H. Rossell & Company, Limited, Sheffield.

Dr. Longmuir has been a very prolific writer of technical papers to various Societies, the Iron and Steel Institute Proceedings containing no less than ten of his contributions. He was joint author with the late Dr. A. McWilliam of "General Foundry Practice," and also published "Elementary Practical Metallurgy," two well-known standard works.

Dr. Longmuir was one of the founders of the Institution of British Foundrymen, and President in 1910 and again in 1911. Apart from his keenness for original research, he is intensely interested in the training of the worker, and for some years has frequently lectured to the numerous Sheffield technical societies. Last week he was elected President of the Sheffield Foundry Trades Technical Society.

Although the work that lies before the new Director is enormous, Dr. Longmuir's ability and knowledge will, without doubt, be equal to it, and the Council of the Association are to be congratulated upon the appointment, which shows the earnestness of their desire to improve the cast-iron industry.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Certificated Foundrymen.

To the Editor of The Foundry Trade Journal.

Sir,—In reading the report of Mr. Young's presidential address to the Newcastle Branch of the Institution of British Foundrymen, which appeared in your journal, I was particularly interested in that part which referred to "Certificated Foundrymen."

It is rather surprising when we realise it that, with the exception of the foundry trades, all important industries have their recognised examinations, the successful passing of which carries the recognition of ability, according to the standard of examination passed. The certificates and, in some instances, medals which are granted are recognised to a more or less degree mainly because they represent the successful result of a course of study in the subject on which the examination has been based. These examinations have undoubtedly an important influence in raising the status of the members of the industry to which they refer. I am therefore entirely at one with Mr. Young that our pressing need is to have some form of test or examination for which members of the foundry trades could work with a desire to hold certificates in their own subject.

Personally, I am of the opinion that if the Institution would decide to hold periodical examinations, the desire for improvement on the part of foundry workers, although probably not at once apparent, would eventually assert itself, and the one important result would be the improvement in status of all concerned with the foundry, whether they were apprentices, journeymen, or foremen.

It is not necessary at this point to make any suggestions respecting the standard of suitable examinations, nor yet is it important to consider the manner in which a certificate will be referred to, that would necessarily need to be defined by a representative body of members, but, once the institution decides to hold examinations, the need for definite qualifications would become equally as necessary to the foundry worker as to the seagoing engineer cited by Mr. Young.

Individual members can do much to uplift the status of the foundry in the manner suggested, but the backing of the Institution would determine an epoch in its history to which members could refer with pride as the time when the Institution decided to give an impetus to the uplifting of those employed within its sphere of influence.—Yours, etc.,

Chas. A. Otto.

22, Owenite Street, Abbey Wood, S.E.2.
October 16, 1922.

Foundry Vacancies.

In our small advertisement pages there appears an appeal by the Secretary of the Lancashire Branch of the Institution of British Foundrymen for positions for disengaged members of the Branch. The Proprietors of The Foundry Trade Journal are willing to insert similar free advertisements for other Branches.

On Saturday, the 14th inst., Mr. F. Clements, of the Park Gate Iron and Steel Company, Limited, lectured before the Rotherham Technical Institute Engineering Society on "Principles and Construction of Siemens Melting Furnaces." Mr. Edward Cross (president) occupied the chair.

Trade Talk.

The Goldendale Iron Company, Limited, restarted one of their blast furnaces recently.

The works of Tolley, Sons & Bostock, ironfounders, of the Green, Darlaston, have been closed.

Mr. W. B. Pickering, a director of Hadfields, Limited, has been appointed Latvian Consular Agent in Sheffield.

Messrs. H. V. Carrington, tool merchants, have removed from 64, Victoria Street, S.W.1, to 28, Victoria Street, Westminster, S.W.1.

Irwin & Jones, Limited, engineers, have removed from 35, Crutched Friars, to 4, Westmoreland Buildings, Aldersgate Street, London, E.C.1.

W. T. Henley's Telegraph Works Company, Limited, have removed their Liverpool branch to larger premises at 37-41, Duke Street, Liverpool.

Mr. W. J. Coles addressed the members of the Sheffield Association of Metallurgists and Metallurgical Chemists last week on the use of pulverised coal.

Holt & Company, of Liverpool, have ordered a new steamer of 7,000 tons, to be built and engined by Scotts' Shipbuilding and Engineering Company, Limited, Greenock.

Edward Pugh & Company, Hall Green Foundry, Wednesbury, have appointed Mr. S. Haynes, 11, Forman Street, Trinity Square, Nottingham, as their agent in the East Midlands.

Lumens, Limited, 11, Cathedral House, Long Millgate, Manchester, have been appointed agents in Lancashire for the Priory Electrical Engineering Company, Bath Street, Birmingham.

Sir W. G. Armstrong, Whitworth and Company, Limited, of Newcastle, have secured the contract for the construction of the new floating dock at Southampton of 60,000 tons lifting power.

Hall Bros., electrical and general engineers, of Edith Walk Works, Malvern, have removed the electrical sales department of their business to 5, The Promenade, Worcester Road, Malvern.

John Cochrane (Barrhead), Limited, of Barrhead, near Glasgow, have secured the contract for the complete pumping installation for Eynsford pumping station for the Metropolitan Water Board.

Mr. J. E. Fletcher delivered a lecture on "Working Slags in Ferrous Processes" before the members of the Birmingham Metallurgical Society at the Chamber of Commerce Buildings, New Street, Birmingham.

The West Cumberland Association of Chemists, Chemical and Metallurgical Engineers, opened its second session at the Technical College, Workington, October 14, when Mr. Laigton Highton, mining engineer, read a paper on "Iron Ore."

Mr. F. Biggin, director of the Brightside Foundry and Engineering Company, Limited, of Sheffield, has been the recipient of a presentation from the directors and staff in recognition of the forty years he has been in the service of the Company.

Centrifugal Separators, Limited, are extending their works at Peckham. The offices at Iddesleigh House will be closed, and all communications should in future be addressed to 161, Queen's Road, Peckham. They will retain their office at 14, Queen Victoria Street, E.C., as hitherto.

Electrical Conduits, Limited, of Walsall, have appointed E. S. Johnson & Company, 126, Pilgrim Street, Newcastle-on-Tyne, as their Newcastle and district agents, and Mr. A. Wheatley, 11, Walker Road, Higher Blackley, Manchester, as agent for Manchester, Liverpool, and district.

A memorial tablet was unveiled and dedicated at the works of Bayliss, Jones & Bayliss, Limited, Monmore Green Ironworks, Wolverhampton, on October 18, in memory of the fifty-five employés of the firm who gave their lives in the war. The memorial was unveiled by Captain Percy T. Bayliss, one of the directors.

Owing to two local foundries having withdrawn their tenders for the supply of iron pipes in connection with the Newport (Monmouthshire) Corporation's new water scheme, the Water Works Committee proposes to award the entire contract to Cochrane and Company, Limited, of Middlesbrough, whose price is £101,960.

The total imports of iron ore into Canada for the 6 months ending June 30 last were 47,219 tons. as compared with 32,131 tons in the first half of 1921. The exports of ore during the same six months were 1,002 tons of iron ore and 489 tons of chromite (chromic iron), as compared with 647 and 1,721 tons respectively in the first half of 1921.

In the forthcoming ballot on the proposals of the Shipbuilding Employers for the removal of the balance of 10s. of the war bonus paid to shipyard workers, provision is made that no reduction will be enforced where the present wage is 37s. 6d. per week. There is thus an assured minimum, and wages, after the reduction has been made, will range from 42s. and more to 37s. 6d.

The members of the Staffordshire Iron and Steel Institute will hold their opening meeting of the session at the Education Offices, St. James' Road, Dudley, on Saturday, October 28, when the president, Mr. Jos. Payton, will give a short address, to be followed by an address by the vice-president, Mr. F. J. Cook, on his American experiences in connection with the iron and steel industries.

It has been announced that following a meeting of the Joint Committee in connection with the hematite pig-iron industry on the West Coast, further negotiations had enabled a settlement of the dispute to be arrived at. The settlement embodies the 1919 sliding scale agreement, with a temporary supplementary arrangement, and it is to operate for governing wages up to the second full pay in July, 1923.

Mr. G. W. Nettleship, managing director of Blair & Company, Limited, Stockton, has resigned his position, and Mr. H. P. Hamilton, the general manager, has taken control, whilst retaining his present post. Mr. L. Parsons has been appointed secretary of the company. Mr. Nettleship, who has been with the company for 36 years, remains at the works by request of the board of management until the end of the year.

The production of pig-iron in Canada during August amounted to 27,123 tons, a decrease of 4,582 tons as compared with the output of July, chiefly attributable to the fuel scarcity. Steel production declined to 59,201 tons in August, as compared with an output of 62,767 tons in July. The August output was 17.8 per cent. less than that for August, 1921, which amounted to 72,023 tons. The cumulative production for the first eight months of this year amounts to 299,048 tons, or 29 per cent. less than that for the corresponding period of 1921.

The total production of steel ingots and castings during the six months ending June amounted to 177,080 tons, of which 169,286 tons were produced for the use in further processes of manufacturing by the makers; the balance, or 7,794 tons, was made for sale. By far the greater amount of the steel made was produced by the basic open-hearth process, the total for this item amounting to 170,182 tons, of which 167,612 tons was in the form of steel ingots and was used by the makers, and the balance, or 3,570 tons, in castings. Of this latter amount, 2,653 tons was made for sale, and 917 tons for the use of the producers. Steel for twenty tons of ingots and 800 tons of castings was made by the Bessemer process. Electric steel production amounted to 4,988 tons, of which 4,861 tons was produced as castings, and 127 tons was in the form of ingots.

The Brassfounders' Employers' Association and the National Brass and Metal Mechanics' Society have arrived at an agreement on the question of a reduction in the war bonus. The employers' original proposal was for a reduction of 16s. a week, to become operative on October 1 last. As the result of negotiations between the parties it was eventually agreed that the "cut" should be 7s. 10d. per week. The agreement arrived at states that the reduction is to operate until the cost of living reaches 51 points over pre-war level. The agreed bonus will therefore be 17s. 7½d. It is also agreed that when the cost of living has reached the level of 51 points the present scheme of the sliding scale shall become operative, and the first further alteration shall be made. The bonus of youths of 18 and 21 years is to be reduced by the amount of 3s. 11d., bringing the total bonus to 9s. 4d. The agreement is subject to notice of three months from either party.

Beginning with January, 1921, a monthly record of the production of pig-iron and ferro-alloys in Canada has been obtained by the Bureau. Blast furnaces were operated during the period by the Algoma Steel Corporation, at Steelton, near Sault Ste. Marie, Ont.; the Dominion Iron and Steel Company at Sydney, N.S.; the Steel Company of Canada at Hamilton, Ont. At the end of June, four furnaces were in blast, two at Sault Ste. Marie, one at Hamilton, and one at Sydney. The average monthly output of pig-iron of all grades for the six months' period was 32,031 tons, of 2,240 lbs. The total for the period was 192,187 tons, as compared with 309,208 tons in the same period of 1921. Of the pig-iron made in 1922, 107,407 tons was produced by firms for their own use, and 84,684 tons was produced for direct sale. A total of 96 tons of electrically-smelted iron made during the period was all for sale. An analysis of the pig-iron output for the six months ending June shows that 56 per cent. of the total was basic iron: 34 per cent. foundry iron, and 10 per cent. malleable iron. Coke was the only fuel used in the manufacture of pig-iron in Canada during the period. The production of ferro-alloys, including the several grades of ferro-silicon, and also spiegeleisen, amounted to 9,671 tons during the half-year.

Company News.

H. I. Baker, Limited.—Capital £1,000 in £1 shares. Engineers. Directors: H. I. Baker and A. E. Garrod.

E. F. Haynes, Limited.—Capital £2,500 in £1 shares. Die sinkers. Directors: E. F. Haynes, F. J. Haynes, P. Farnell and W. E. Alldritt.

Ashton Vale Iron Company, Limited.—No allowance for depreciation; loss, £1,882; debenture interest, £364; brought forward, £594; net debit balance, £1,652.

Allen Everitt & Sons, Limited.—Interim dividends: Preference shares, 6 per cent. per annum, less tax; ordinary shares, 7½ per cent. per annum, free of tax.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Profit for 1921, £438,888; brought forward, £921,329; ordinary dividend for year, 1s. per share, or 5 per cent.; carried forward, £832,092.

I. P. M. Syndicate, Limited, 82, Victoria Street, Westminster, London, S.W.—Capital £15,000 in 12,000 10 per cent. cumulative preference shares of £1 and 60,000 deferred shares of 1s. Mechanical engineers.

Eclipse Engineering Company, Limited, Eclipse Engineering Works, Manchester Road, Westhoughton. —Capital £600. Directors: S. Ogden, H. O. Dixon, F. Ratcliffe, W. Harrison, C. C. Abbott and J. Horrocks.

Charles Bell, Limited, Iron Works, Bath Street, Leeds.—Capital £15,000 in £1 shares (7,500 5 per cent. cumulative preference and 7,500 ordinary). Mechanical and electrical engineers. Directors: Lazarus Bell, Leonard Bell, and H. H. Cassé.

James Y. Millar & Company, Limited, 62, Robertson Street, Glasgow.—Capital £5,000 in 1,500 cumulative preference shares of £1 and 7,000 ordinary shares of 10s. each. Iron, steel and metal merchants. Directors: J. Y. Millar and R. H. Dempster.

Burne-Jones & Company, Limited, Montford Place, Kennington Road, London, S.E.—Capital £3,000. Consulting, mechanical and construction engineers, etc. Directors: D. Burne-Jones (managing director), F. W. Ward, J.P. and F. Foulger (all permanent).

Vulcan Foundry, Limited.—Profit, £250,611; rent of houses, £1,992; interest and discount, £2,483; registration fees, £64; total, £225,151; directors' fees, £5,209; depreciation, £44,166; reserve for trade taxation, £20,000; brought forward, £188,684; interest received, £13,386; available, £387,845; transferred to capital account in respect of bonus shares issued, £76,827; balance of income-tax, £22,173; ordinary dividend, 15 per cent. for year.

Contracts Open.

Bangkok, Siam, January 31.—Supply of railway store materials for the Department of State Railways. C. P. Sandberg, 40, Grosvenor Gardens, London, S.W.1. (Fee, £2 12s.)

Leeds, November 10.—Supply of iron castings to the electricity department during six or twelve months, commencing January 1, 1923 for the Corporation, 1, Whitehall Road, Leeds.

Llanbedr, October 27.—For providing and laying about 3,000 lineal yards of 3-in. cast-iron pipes, for the Dolgelley Rural District Council. Mr. R. Foulkes-Jones, clerk, Bank Chambers, Llwyngwril, S.O., or Mr. F. J. Rodwell (Spinks, Pilling & Rodwell), 37 and 38, Prudential Buildings, Park Row, Leeds. (Fee £1, returnable.)

Scunthorpe, October 31:—Supply, delivery and jointing of about 600 ft. of 20-in. cast-iron gas mains and specials, for the new gasworks, for the Scunthorpe and Frodingham Urban District Council. Mr. J. F. Simpson, engineer and manager, Gasworks, Scunthorpe.

Wallingford, October 28.—Supply and fixing of four "luted" purifier covers for 12-ft. square boxes. Also an alternative tender for "luteless" covers for the same boxes. The Manager, Gasworks, Wallingford, Berks.

London, S.W., October 27-31-November 3.—The High Commissioner for India is prepared to receive tenders for supply of (1) copper plates for locomotive fireboxes; (2) boiler tubes, brass; (3) pillar water cranes; (4) steel tyres for engines and tenders; (5) electric jib crane and electric overhead crane; (6) buffers; (7) boiler tubes, solid drawn steel; (8) mild steel sheets, galvanised, corrugated. The Director-General, India Store Department, Branch No. 12, Belvedere Road, Lambeth, S.E.1. Tenders by October 27 for Nos. 1 to 3; October 31 for No. 4; and November 3 for Nos. 5 to 8.

The late Mr. J. Skinner, metal merchant, of West Lynn, Norfolk, left £7,593.

Gazette.

A receiving order has been issued against Messrs. W. H. B. Troman & Company, 34, Rooth Street, Wednesbury, metal merchants.

Messrs. H. Bufton, W. Marples, and C. Marples, electrical engineers, Fornham Street, Sheffield, trading under the stylo of Lee & Bufton, havo dissolved partnership.

Messrs. C. H. Fisher and C. Law, consulting engineers and agents, 20, Westminster Palace Gardens, Westminster, S.W., trading under the style of Fisher and Law, have dissolved partnership.

Trading in the stylo of J. Lyon & Company, Messrs. F. Lyon and R. Lunt, 90, Cranmer Street, Liverpool, iron, steel and nail merchants, havo dissolved partnership. Debts by F. Lyon, who continues the business.

Messrs. J. Garbett, J. W. Shepherd, A. R. Frier and A. H. Duffield, ironfounders, 75, New Street, West Bromwich, trading under the style of the New Malleable Foundry Company, have dissolved partnership.

The partnership heretofore subsisting between Messrs. T. W. Craig and E. H. Wells, electrical engineers, 3, Church Road, Waterloo, Lancaster, under the style of T. W. Craig & Company, has been dissolved.

Messrs. W. Jordan and J. Charlesworth, oxy-acetylene welders and general engineers, 3, Deacon Street, Leicester, trading under the style of the Oxy-Acetylene Welding and Engineering Company, have dissolved partnership.

Mr. A. H. Standley, Roebuck Lane, West Bromwich, scrap metal merchant, has been adjudicated bankrupt. First meeting, O.R.'s, Birmingham, October 30, at 11. Exam., Law Courts, West Bromwick, November 17, at 11. Adj., October 12.

A petition for the winding-up of Sheffield Steel Products, Limited, has been presented by Hemmings & Company, Limited (in liquidation), of Paradise Street, Sheffield, creditors of the Company. The petition will be heard in London on October 31.

Trading in the style of the Midland Brassfounders, Messrs. J. O. Widdop, C. Marshall, and W. Holmes. Falcon Works, 33, Sherwood Rise, Nottingham, brassfounders and finishers, have dissolved partnership. Debts by Messrs. C. Marshall and W. Holmes, who continue the business.

The partnership heretofore carried on by Messrs. H. O'Brien and H. W. O'Brien, iron founders, iron merchants and dealers, at 17, Upper Thames Street, London, E.C., and the Effingham Works, Rotherham, under the style of O'Brien, Thomas & Company, Yates, Haywood & Company, and Skelton, Corbitt & Company, has been dissolved. In future the business will be continued by H. O'Brien, H. W. O'Brien, T. O'Brien, E. H. Howard, and A. P. Harrop.

In the Companies (Winding-up) Court last week, Mr. Justice Lawrence heard a petition by Plenty & Son, Limited, creditors against the Rennie, Ritchie and Newport Shipbuilding Company, Limited, for a supervision order, the appointment of another liquidator to act with Mr. F. Whinney, the present liquidator, and the appointment of a committee of inspection. His Lordship made a supervision order and appointed a committee of inspection.

Deaths.

Mr. J. Clucas, manager of Gelling's Foundry, Limited, South Quay, Douglas, Isle of Man, died on October 1.

Mr. Thomas B. Hosking, of John Hosking & Sons, iron and metal merchants, 10, Albert Embankment, London, S.E.11, died on October 3, aged 77.

Mr. A. S. Holdsworth, managing director and secretary of H. S. Holdsworth, Limited, coppersmiths, brass finishers, etc., of Halifax, died recently in his 57th year.

Mr. R. Hartley, at one time senior partner of R. Hartley & Sons, metal merchants, Long Brackland, Bury St. Edmunds, died recently at the age of 74 years.

Mr. David William Rennie, of the firm of John T. Rennie, Son & Company, died at Sidmouth, South Devon, last week. The fifth son of Mr. John T. Rennie, of Aberdeen, the founder of the firm that bears his name, Mr. David Rennie, who was 56 years old, had been with the firm since boyhood, and was a partner for thirty years.

Mr. Charles Curry Swinburne, J.P., head of the Wallsend firm of M. W. Swinburne & Sons, Limited, brassfounders, engineers and coppersmiths, has died as the result of an accident. Mr. Swinburne, who was 50 years of age, was a son of the late Councillor M. W. Swinburne, a former Mayor of Wallsend, who died during his year of office. He was a Justice of the Peace for Wallsend.

IRON AND STEEL MARKETS.

Pig-iron.

The outlook in the pig-iron industry, though somewhat more promising than recent reports would appear to indicate, continues indefinite, and is apparently largely dependent upon an early expansion of home consumption which is unfortunately slow in materialising. Meanwhile, it is satisfactory to record that the heavy stocks in makers' yards a short time ago have been almost entirely absorbed by the recent American demand, which although on a diminishing scale, is confidently expected to continue over the end of the current year. The Continent, also, has lately been buying in substantial volume, but in the majority of cases British makers are unable to give such early delivery as foreign producers, as notwithstanding the increased output at home furnaces, the bulk is absorbed in filling contracts already entered into with America. A hopeful feature of the pig-iron market is the improved demand that has sprung up of late from the home foundries. In the Midlands, the markets for pig continue unsatisfactory, due to the slackness of the home demand, as trade in these districts has been practically unaffected by the recent boom in exports. Prices, however, are firmly maintained, and business is almost entirely confined to hand-to-mouth deliveries, mostly of Derbyshire and Northamptonshire makes, South Staffordshire furnaces remaining in the majority of plants unproductive. Scottish makers are still busy completing American contracts in hand, which for the present afford an outlet for their furnace outputs, but with the cessation of the export demand will find some difficulty in keeping plants fully employed. At Teesside, notwithstanding the heavy shipments which have been made this month to America, makers have still sufficient orders in hand to keep them busy for some time to come, and a moderate business is being negotiated for further supplies both of foundry iron to special analysis and of the standard No. 3. A certain amount of basic iron is also being bought. Producers look for a temporary continuance of this business, for costs of production in the U.S.A. continue to be very high, while apart from that it will take time to make up the existing shortage. The home trade is slowly improving. Consumers who have been recently buying on a restricted scale now see that there is little prospect of any early easing in prices, and are covering their requirements till the end of the year. The export trade with the Continent is quiet. Buyers abroad cannot apparently afford to pay the price now being demanded, especially in view of the acute difficulties created by the exchange position. Meanwhile, quotations are very firmly held at last week's levels, as follows:—No. 1 and silicious, 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s.

In regard to hematite pig-iron the recent sharp American demand has effected a complete change in the position. Makers having practically cleared out their stocks, which had looked like being a heavy drag over the winter, are now comfortably placed. On the whole, apart from the influence of rising fuel costs, there is a tendency for prices to stiffen, and at last week's market 92s. 6d. was generally the minimum figure for East Coast mixed numbers, with 6d. to 1s. extra for the No. 1 quality. West Coast hematite prices are unchanged, Bessemer mixed numbers being quoted at 100s. per ton delivered at Glasgow and Sheffield, and for export at 102s. 6d. to 105s. per ton.

Finished Iron.

There is very little, if anything, of interest to note in the conditions of the markets for finished material, the continued inactivity of the consuming industries retarding any expansion of demand at home, while an increased export trade is rendered difficult by the violent fluctuations in the foreign exchanges. At Birmingham last week the volume of business passing in this section was again disappointing, and from a prices point of view, conditions were rather worse than they have been. Makers of marked bars are, however, still comparatively steadily employed, although forward business to any extent is hard to obtain, and the orders in hand are barely sufficient to keep mills working for anything like full time. The list houses still maintain quotations on the basis of £13 10s. for marked bars, owing to the continued high cost of production, while crown qualities can be bought round about £10 15s., whereas the actual cost of manufacture is stated to be upwards of £11. Gas strip, also at £10 15s., is not covering costs, and the South Staffordshire firm who recently restarted their works after having had them idle for well over a year are contemplating closing them again. The inquiry for nut and bolt iron has decreased, and the price has fallen to £9 15s. Special irons continue to feel the pressure of steel competition. The much lower price at which the latter can be obtained is severely restricting the demand for cable and such irons.

Scrap.

Business in most sections of the scrap-metal trade remains without any marked improvement, with, perhaps, an exception in the case of heavy steel material, in which some gradual expansion of demand may be noted. Dealings, however, in this quality of scrap are limited to unimportant quantities, but demand is certainly more active, and with supplies of the right kind rather on the scarce side prices in the Cleveland market are advancing. Last week 67s. 6d. per ton was paid, as against 65s. previously quoted. Heavy steel turnings were also a good market, with the price firm at 53s. 6d., while cast-iron borings were realising 52s. 6d. There is now a little quiet buying in heavy cast-iron machinery scrap in handy pieces, for which 75s. to 77s. 6d. is named, ordinary descriptions offering at 70s. to 72s. 6d. Heavy wrought iron is still idle, the nominal prices being 55s. to 57s. 6d. for bushelling, 60s. for ordinary heavy piling, and 70s. to 75s. for specially selected heavy forge. All quotations are delivered works.

Steel.

A steady, if gradual, improvement may again be reported in steel-trade conditions, and although many plants in the chief manufacturing centres are still only partially employed, the outlook may be confidently regarded as more favourable than for a long time past. More especially does this tendency apply in the markets for Welsh semi-products, in which determined efforts are in evidence to exclude foreign bars by the assistance makers are giving to the tinplate makers for the purpose of maintaining a minimum basis price. As has been repeatedly pointed out of late, the Welsh makers were badly in need of specifications, and unless a change came over the market some of the works would have to shut down. While Welsh producers have found it necessary to maintain the price of sheet and tinplate bars at £7 7s. 6d., the Continental makers have been cutting in at under £6 15s. delivered, and have naturally monopolised any business offering, particularly as their delivery has not been unduly delayed. The Lincolnshire and other makers have also been underquoting the Welsh, with the result that the latter have now arranged to supply the tinplate makers at £7, providing the tinplate mills maintain a minimum of 19s. 3d. per standard box. In the Sheffield steel market prices are firm for both acid and basic billets, though buying is only moderate. In all the cheaper steels there is quite active business, and the exports of these are now in considerable volume. For the costly special steels there is very little demand, and practically none of it is leaving the country owing to the high prices asked. At some of the rod and strip mills almost full time is being worked at present, an encouraging sign of revival. Some orders in connection with shipbuilding work have come to the aid of the casting and forging departments of a few of the local works. The demand for ferro-alloys is fair on home account, and for export several inquiries are in circulation. It is impossible to quote American ferro-manganese, as the makers have not yet announced prices. Ferro-silicon has shed a few more shillings in both 45 per cent. and 75 per cent. grades, and one or two nice orders have been placed at just over £11 per ton, delivered, for 45 per cent. High-carbon ferro-chromes are in moderate request, with prices fairly steady, and a slight tendency to harden in the 4/6 per cent. grade. More interest is evinced in the refined grades, a considerable amount of which is destined for manufacturing into stainless steel, for which a better demand is apparent. The tone of the tinplate market is steady, though the business going through is not large, but there is a better feeling about, and as the makers are about to take combined action to regulate output in accordance with demand, several buyers consider the present a good time to cover their requirements. 19s. has been freely paid for the standard sizes, but 3d. extra is now required. Current quotations for coke finish are firm, as follows:—IC 14 x 20, 112 sheets, 108 lbs., 19s. 3d. per box: IC 28 x 20, 112 sheets, 216 lbs., 38s. 6d. per box; light and crosses at usual differences, net cash, f.o.b. Wales

Metals.

Copper.—Business in the standard market for this metal during the past week has been somewhat irregular, values fluctuating from day to day, while home consumptive demand has been by no means active. Smelter output in the United States in September is estimated at about 85,000,000 pounds. Stocks of blister copper having been almost exhausted, the September production of refined copper is estimated at 130,000,000 pounds, being about 30,000,000 pounds less than combined deliveries into domestic and foreign consumption, thus indicating a decrease of about 30,000,000 pounds in stock, which on October 1 stood at 270,000,000 pounds. Deliveries into domestic consumption are estimated at 100,000,000 pounds. Current quotations :—*Cash* : Wednesday, £62 5s. ; Thursday, £62 ; Friday, £61 17s. 6d. ; Monday, £62 10s. ; Tuesday, £63. *Three months* : Wednesday, £62 15s. ; Thursday, £62 15s. ; Friday, £62 12s. 6d. ; Monday, £63 5s. ; Tuesday, £63 12s. 6d.

Tin.—Interest in the metal markets of the week has again been centred on the continued buoyancy of the tin section in which the business transacted has been on a scale of exceptional magnitude, with values daily progressing in an upward direction. So far this month tin has appreciated £8 7s. 6d. for cash delivery. New records for the year have been realised at £172 7s. 6d. and £35 15s. respectively. At last week's close tin values wavered somewhat. Some fluctuations are expected, although there is reason for believing that the upward movement will eventually proceed further. Consumption is more than sufficient to absorb current production. Current quotations :—*Cash* : Wednesday, £171 ; Thursday, £172 5s. ; Friday, £171 15s. ; Monday, £173 5s. ; Tuesday, £174 7s. 6d. *Three months* : Wednesday, £171 15s. ; Thursday, £173 5s. ; Friday, £172 15s. ; Monday, £174 2s. 6d. ; Tuesday, £175 2s. 6d.

Spelter.—Quotations for spelter continue on the upgrade, and have now reached levels much above the intrinsic value of the metal. Consistent reports are circulated with regard to the scarcity of supplies, but although, undoubtedly, there are no particularly large quantities of spelter available, too much has been made of this restriction, and prices now current by no means reflect the true position of the metal. However, the quantity of concentrates arriving is steadily increasing, and the position shortly should be somewhat alleviated. Current quotations :—*Ordinary* : Wednesday, £34 10s. ; Thursday, £35 2s. 6d. ; Friday, £33 2s. 6d. ; Monday, £35 17s. 6d. ; Tuesday, £36 2s. 6d.

Lead.—A feature in the market for soft foreign pig of late has been the increased turnover in lead, but it is to be feared that a lot of the business done has been on speculative account. The amount of genuine business doing for consumers is very small, and while the stocks in the United Kingdom are stated to be only 583 tons, everybody connected with the trade is fully aware of the fact that this does not represent the exact position, there being lead in other warehouses. Current quotations :—*Soft foreign (prompt)* : Wednesday, £25 7s. 6d. ; Thursday, £25 2s. 6d. ; Friday, £25 7s. 6d. ; Monday, £25 7s. 6d. ; Tuesday, £26 10s.

Production Engineers' Gathering.

Members of the Institution of Production Engineers and their friends spent an interesting evening at the Royal Automobile Club on Friday last, on the occasion of the opening meeting of the session. This newest of engineering associations has been largely brought about by the intensive manufacturing conditions that prevail in the engineering world to-day. It exists primarily with the object of bringing manufacturing engineers into touch with one another, with a view to an interchange of ideas in the latest works practice. After the reception a short Presidential Address was delivered.

Foundry Cupolas,

In Mr. E. A. Roper's article an unfortunate mis-print crept in. Under the heading of "Tuyeres," on page 322, the second paragraph instead of "This would be most marked in a large cupola with a large charging hole," read "This would be most marked in a large cupola with a low charging hole."

Telephone : 21, Penistone. Telegrams : "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

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Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	0	0
Three months	63	12	6
Electrolytic	70	5	0
Tough	65	5	0
Best selected	65	5	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	0	0
Do. Nov.	70	0	0
Do. Dec.	70	0	0
Ingot bars	70	0	0
H.C. wire rods	74	15	0
Off. aver. cash, Sept. 63	3	4	5/7
Do. 3 mths., Sept. 63	12	5	3/7
Do. Settlement Sept. 63	2	11	5/7
Do. Electro, Sept. 71	3	2	4/7
Aver. spot price, copper, Sept.	63	2	7½
Do. Electro, Sept. 71	8	1	
Solid drawn tubes		13½d.	
Brazed tubes		13½d.	
Wire		10½d.	
Yellow metal rods		6½d.	
Do. 4x4 Squares		8½d.	
Do. 4x3 Sheets		9½d	

BRASS.

Solid drawn tubes	11¾d.
Brazed tubes	13½d
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9¾d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	174	7	6
Three Months	175	2	6
English	174	5	0
Bars	176	5	0
Chinese	173	10	0
Straits	175	12	6
Australian	175	15	0
Eastern	176	10	0
Banca	174	12	6
Off. aver., cash, Sept.	160	2	8 1/7
Do. 3 mths., Sept.	160	0	7 6/7
Do. Sttlment. Sept.	160	2	3 1/7
Aver. spot, Sept.	160	1	3¾

SPELTER.

	£	s.	d.
Ordinary	36	2	6
Remelted	33	0	0
Hard	26	10	0
Electro 99.9	38	10	0
English	36	0	0
India	27	10	0
Prime Western	36	0	0
Zinc dust	48	0	0
Zinc ashes	11	0	0
Off. aver., Sept.	31	8	8 9/14
Aver., spot, Sept.	31	14	10½

LEAD.

	£	s.	d.
Soft foreign ppt	26	10	0
English	27	10	0
Off. average, Sept.	23	16	3 5/14
Average spot, Sept.	24	2	9

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	40	0	0
Do. V.M. ex. whf.	40	5	0
Dutch	40	0	0
Rods	45	10	0
Boiler plates	38	10	0
Battery plates	39	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	10	0
Crude	18	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	11	12	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon— 45/50%	11	2	6
75%	19	10	0
Ferro-vanadium— 35/40%	17/- lb. va.		
Ferro-molybdenum— 70/75%	8/9 lb. mo.		
Ferro-titanium— 23/25%, carbonless	1/2 lb.		
Ferro-phosphorus, 20/23%,	£24		
Ferro-tungsten— 80/85%, carbon free	1/5 lb.		
Tungsten metal powder— 98/99%	1/11 lb.		
Ferro-chrome— 4/6% car.	£23	5	
6/8% car.	£22	15	
8/10% car.	£22	10	
Ferro-chrome— Max. 2% car.	£55		
Max. 1% car.	£68		
Max. 0.70% car.	£75		
67/70%, carbonless	1/6½ lb.		
Nickel—99%, cubes or pellets	£140		
Cobalt metal—98/99%	12/- lb.		
Aluminium—98/99%	£95		
Metallic Chromium— 96/98%	4/9 lb.		
Ferro-manganese(net)— 76/80%, loose	£15		
76/80%, packed	£16		
76/80%, export	£14	10	
Metallic manganese— 94/96%, carbonless	2/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
- Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
- Rounds and squares under ½ in. to ¼ in. 3d. lb.
- Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. 3d. lb.
- Bevels of approved sizes and sections .. 6d. lb.
- If in coils .. 3d. lb.
- Packing .. £3 ton.
- Bars cut to length 10% extra

Scrap from high-speed tool steel—
- Scrap pieces .. 3d.
- Turnings and swarf .. 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales— Heavy Steel	3	10	0
Bundled steel & shearings	2	19	0
Mixed iron & steel	2	17	0
Heavy cast iron	3	10	0
Good machinery for foundries	4	0	0
Cleveland— Heavy steel	3	7	6
Steel turnings	2	13	6
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	16	3
Cast-iron scrap	3	11	3
Lancashire— Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6
London— Copper (clean)	56	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	21	10	0
Tea lead	19	0	0
Zinc	20	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast— Foundry No. 1	97/6
Foundry No. 3	92/6
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	93/9
Hematite M/Nos.	92/6
Midlands— Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland— Foundry No. 1	105/-
„ No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)— Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	87/6
„ basic	86/6
E.C. hematite	102/-
W.C. hematite	102/6

All d/d in the district.

Lancashire (d/d eq. Man.) — Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.
Iron— Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	15	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	10	15	0
Bolts and nuts, ¾ in. × 4 in.	17	10	0
Steel— Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ⅜in.	8	15	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1¼in.	8	5	0
Rails, heavy	8	15	
Fishplates	14	10	
Hoops	£11 0 0 to 11	10	
Black sheets, 24 g.	12	0	
Galv. cor. sheets, 24 g.	16	5	
Galv. fencing wire, 8 g. plain	16	0	
Rivets, ¾ in. dia	12	15	
Billets, soft	7 0 0 to 7	2	
Billets, hard	8	0	
Sheet bars	6 17 6 to 7	7	

PHOSPHOR BRONZE.

	Per l. base
Strip	1
Sheet	1
Wire	1
Rods	1
Tubes	1
Castings	1

Delivery 3 cwt. free to an town.

10% phosphor copper, £ above price of B.S.

15% phosphor copper, £ above price of B.S.

Phosphor tin (5%), £30 abo price of English ingots.

Charles Clifford & So Limited, Birmingham.

NICKEL SILVER, SHEE METAL, WIRE AND TUBE

	Per lb.
Ingots for raising	11d. to 1/
Rolled— To 9 in. wide	1/5 to 1/1
To 12 in. wide	1/5½ to 1/11
To 15 in. wide	1/6 to 2/
To 18 in. wide	1/6¾ to 2/0
To 21 in. wide	1/7½ to 2/1
To 25 in. wide	1/8¼ to 2/
Ingots for spoons and forks	11d. to 1/
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3

with extras according to gaug

AMERICAN IRON & STEEL

At Pittsburgh unless otherwi stated.

	Dol
No. 2X foundry, Phila.	33.1
No. 2 foundry Valley	32.5
No. 2 foundry, Birm.	27.5
Basic	32.9
Bessemer	35.2
Malleable	32.0
Grey forge	33.7
Ferro-manganese 80 % delivered	75.0
Bess. rails, h'y, at mill	43 0
O.-h. rails, h'y, at mill	43.0
Bess. billets	40.0
O.-h. billets	40.0
O.-h. sheet bars	40.0
Wire rods	45.0

	Cents
Iron bars, Phila.	2.4
Steel bars	2.0
Tank plates	2.1
Beams, etc.	2.0
Skelp, grooved steel	2.0
Skelp, sheared steel	2.0
Steel hoops	2.9
Sheets, black, No. 28	3.5
Sheets, galv., No. 28	4.5
Sheets, blue an'l'd, 9&10	2.6
Wire nails	2.7
Plain wire	2.4
Barbed wire, galv.	3.3
Tinplate, 100-lb. box	$4.7

COKE (at ovens).

Welsh foundry	35/- to 37/6
„ furnace	26/- to 27/6
Durham & North. foundry	30/-
„ furnace	27/
Other Districts, foundry	30/-
„ furnace	26/

FLANGED STEEL TUBES and BRANCHES.
FOR
HIGH PRESSURE WORK.
WATER MAINS UP TO 4ft. DIAMETER.

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EXPORTERS OF EVERY DESCRIPTION OF
SWEDISH CHARCOAL IRONS, SWEDISH BESSEMER and SIEMENS-MARTIN STEELS, Ingots, Billets, Hammered and Rolled Bars, Hollow Drill Steel, Wire Rods, etc., etc.

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54 Prize Medals and Diplomas of Honour.
Highest Award wherever exhibited.
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September 30th, 1922.

BLAST FURNACES OF THE UNITED KINGDOM

BUILT AND IN BLAST.

Compiled from Returns Received Direct from the Furnaces, and Published at the Offices of

BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C. 2
(Telegrams: ZACATECAS, WESTRAND, LONDON Telephone: GERRARD 8811 (2 Lines))

THE FOUNDRY TRADE JOURNAL, WITH WHICH IS INCORPORATED THE IRON & STEEL TRADES JOURNAL.

BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C. 2
(Telegrams: ZACATECAS, WESTRAND, LONDON Telephone: GERRARD 8811 (2 Lines))

These Statistics have been published regularly each Quarter since 1879.

Total number of Furnaces Built on September 30th, 1922	487
Total number of Furnaces in Blast on September 30th, 1922	138
Increase in the number of Furnaces Built ...	1
Increase in the number of Furnaces in Blast since June 30th, 1922	21
Furnaces Blown-in since June 30th, 1922	25

Scotland (7):—1 Dalmellington Iron Co., Ltd., 3 Shotts Iron Co., Ltd., 3 Dalzell & Co., Ltd.

Lincolnshire (1):—John Lysaght, Ltd., 1.

Cleveland (2):—Sir R. Samuelson & Co., Ltd., Bernard Loog & Co., 1.

North Staffordshire (2):—R. Heath & Low Moor, Ltd., Stafford Coal & Iron Co., 1.

Lancashire (1):—Thurwood Iron Co., 1.

Northamptonshire (2):—United Steel Companies, 1, Kettering Iron and Coal Co., 1.

South Wales (1):—Guest, Keen & Nettlefolds, 1.

Nottingham and Leicestershire (1):—Stanton Ironworks Co., 1.

West Cumberland (1):—Millom & Askam Hematite Iron Co., 1.

South and West Yorkshire (2):—Parkgate Iron and Steel Co., 1, Yorkshire Iron & Steel Co., 1.

Derbyshire (4):—Stanton Ironworks Co., 2, Denby Iron and Coal Co., 1, Staveley Coal and Iron Co., 1.

South Staffordshire, etc. (1):—Earl of Dudley, 1.

Furnaces Blown-out since June 30th, 1922 — 4

South Wales (3):—Ebbw Vale Steel, Iron and Coal Co., 3.

South and West Yorkshire (1):—Walter Scott, Ltd., 1.

Furnaces being built at present time — 17

(See below).

Furnaces being Re-lined at present time — 61

Durham (4):—Consett Iron Co., Ltd., 2, Claude Hunter Co., 1, Pease & Partners, 1.

Nottingham and Leycestershire (1):—Stanton Ironworks Co., 1.

Cleveland (20):—Bolckow, Vaughan & Co., Ltd., 10; Sir R. Samuelson & Co., Ltd., 1; Dorman, Long & Co., Redcar, 1, Skinningrove Iron Co., Ltd., 2; Cochrane & Co., 2; Pease & Partners, 2; Cargo Fleet Iron Co., 1; North Eastern Steel Co., 1.

South Staffordshire (2):—E. & R. Thomas, 1; Alfred Hickman, 1.

Staffordshire North (2):—Robert Heath & Low Moor, 1; Shelton Iron Steel and Coal Co., 1.

South and West Yorkshire (1):—Robert Heath & Low Moor, 1.

Cumberland (4):—United Steel Companies (Workington), 3; ditto (Distington), 1.

Derbyshire (6):—Shropshire Coal and Iron Co., Ltd., 1; Clay Cross Co., Ltd., Stanton Ironworks Co., 2; Denby Iron and Coal Co., 1; Staveley Coal and Iron Co., 2.

Northamptonshire (2):—Kettering Iron and Coal Co., 1; New Transley Iron Co., 1.

Lincolnshire (3):—North Lincolnshire Iron Co., Ltd., 1; Frodingham Iron and Steel Co., 2.

Lancashire (6):—North Lonsdale Iron and Steel Co., Ltd., 2; Barrow Hematite Steel Co., Barrow and Hindpool Iron Co., 1; Wigan Coal and Iron Co., 2.

Scotland (5):—James Dunlop & Co., 1; Wm. Dixon, 2; Carnbroe Iron Co., 1; Merry & Cunninghame, 1.

South Wales (5):—Ebbw Vale Steel, Iron and Coal Co., Ltd., 2; Guest, Keen & Nettlefolds, Ltd., 2; Blaenavon Co., Ltd., 1; Briton Ferry Works, 1.

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Scotland.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Langloan Iron and Furnace Co., Ltd., Coatbridge	—	—	—	—	—	—	—
Coltness Iron Co., Ltd., Fullwood	—	—	—	—	—	—	—
Dixon, Wm., Ltd., Calder	—	—	—	—	—	—	—
Dixon, Wm., Ltd., Govan	—	—	—	—	—	—	—
Dunlop, Jas. A. Co., Ltd., Johnstone	2	1	2	1	—	—	—
Glasgow Iron and Steel Co., Ltd., Wishaw	—	—	—	—	—	—	—
Merry and Cunninghame, Ltd., Cardiff	—	—	—	—	—	—	—
Monkland Iron Co., Ltd., Coatbridge	4	—	4	3	1	—	—
Summerlee Iron Co., Ltd., Coatbridge	3	—	—	3	3	—	—
Baird, Wm. & Co., Ltd., Cleland, Motherwell	4	—	4	4	4	—	—
Baird, Wm. & Co., Ltd., Gartsherrie	—	—	—	—	—	—	—
Baird, Wm. & Co., Ltd., Muirkirk	—	—	—	—	—	—	—
Bairds & Dalmellington Iron Co., Ltd., Dalmellington	1	—	1	—	1	—	—
Merry & Cuninghame, Ltd., Ardeer	6	—	6	4	1	—	—
David Colville & Sons, Ltd., Glengarnock	2	—	—	2	1	—	—
Carron Co., Carron	—	—	—	—	—	—	—
Totals	23	1	21	—	18	1	12

North Wales.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Brymbo Steel Co., Ltd.	—	—	—	—	—	—	—
Darwen & Mostyn Iron Co., Ltd., Mostyn	*2	—	—	2	2	—	—
Totals	2	—	—	2	2	—	—

*Two furnaces making ferro-manganese, etc.

South Wales & Mon.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Briton Ferry Works, Ltd.	1	1	—	—	1	1	—
Dowlais, Ltd., Cyfarthfa Works, Merthyr	1	—	—	1	1	2	—
Dowlais, Ltd., Dowlais Hematite Works, Landore	1	—	—	1	1	2	—
Crawshay Bros. (Cyfarthfa), Ltd.	—	—	—	—	—	5	—
Guest, Keen & Nettlefolds, Ltd., Dowlais	2	2	—	2	2	4	1
Guest, Keen & Nettlefolds, Ltd., Cardiff	1	1	—	1	—	4	—
Guest, Keen & Nettlefolds, Ltd. (Penallta), Mon.	—	—	—	—	—	4	—
Blaenavon Co., Ltd., Blaenavon	1	1	—	1	1	3	1
Ebbw Vale Steel, Iron and Coal Co., Ltd., Ebbw Vale	2	1	—	2	1	3	1
Pyle & Blaina Works, Ltd.	—	—	—	—	—	—	—
Totals	6	5	—	1	8	8	1

Durham and Northumberland.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Larbon Iron Co., Ltd., Derwenthaugh	*1	—	—	1	1	1	—
Bell Bros., Ltd., Clarence Works	2	—	—	2	2	2	—
Consett Iron Co., Ltd., Consett	2	2	—	2	2	5	—
Hardwick Furnaces, Ltd.	—	—	—	—	—	—	—
Palmers Shipbuilding and Iron Co., Ltd., Jarrow	—	—	—	—	—	—	—
Lindthorpe, Dixon & Co., Ltd., Middleton Steel Works, Ltd., Middleton	12	—	—	2	2	4	—
Beaumont Carnaby Iron Co., Ltd., West Hartlepool	1	1	—	1	1	4	—
Pease & Partners, Ltd., Teesbridge Iron Works, Darlington	—	—	—	—	—	—	—
Weardale Steel, Coal and Coke Co., Ltd., Tudhoe Furnaces, Spennymoor	—	—	—	—	—	—	—
Totals	4	3	—	2	8	8	1

*Two furnaces making ferro-manganese, etc.
†Two furnaces ditto.

Lincolnshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Appleby Iron Co., Ltd., Frodingham	—	—	—	—	—	7	—
Frodingham Iron and Steel Co., Ltd., Dunswell	2	—	—	2	2	4	2
Redbourn Hill Iron and Coal Co., Ltd.	2	—	—	2	2	4	—
North Lincolnshire Iron Co., Ltd., Scunthorpe	—	—	—	—	—	3	1
Trent Iron Co., Ltd., Scunthorpe	2	—	1	1	2	2	—
John Lysaght, Ltd., Normanby Park Steel-works, Scunthorpe	4	—	2	2	3	4	1
Totals	10	—	3	7	9	13	3

Notts. and Leicestershire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Brettwood Coal and Iron Co., Ltd., near Nottingham	—	—	—	—	—	4	—
Stanton Iron Works Co., Ltd., Ilkeston	3	—	3	3	2	4	1
Totals	3	—	3	3	2	8	1

Shropshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Madeley Wood Co.	—	—	—	—	—	2	—
Lilleshall Co., Ltd.	1	—	—	1	1	4	—
Totals	1	—	—	1	1	6	—

Cleveland District.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
North Eastern Steel Co., Middlesbrough	2	—	—	2	2	4	1
Dorman, Long & Co., Ltd., Middlesbrough	2	2	—	1	2	6	1
Bolckow, Vaughan & Co., Ltd.—							
Clay Lane	—	—	—	—	—	4	2
Cleveland, South Bank	—	—	—	—	—	5	1
Cleveland Steel Works, Tipton	—	—	—	—	—	2	1
Middlesbrough	*3	—	—	3	2	3	1
Grangetown	*3	—	—	3	2	3	1
Skinningrove Iron Co., Ltd., Skinningrove	2	2	—	2	2	6	1
Dorman, Long & Co., Ltd., Britannia Ironworks, Middlesbrough	2	—	—	2	2	6	—
Sir R. Samuelson & Co., Ltd., Ironmasters, Middlesbrough	3	2	1	—	2	8	1
Pease & Partners, Ltd., Normanby Iron Works	2	2	—	2	3	3	1
Cochrane & Co., Ltd., Redcar Ironworks	2	—	1	—	2	5	1
Eston Hematite Iron Co., Ltd., Eston	2	—	—	2	2	6	2
Cargo Fleet Iron Co., Ltd., Middlesbrough	2	—	—	2	2	6	1
Totals	23	6	1	18	24	71	13

*Cold Blast.

West Cumberland.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
United Steel Companies Ltd., Derwent Hartpool, Solway Mills, Workington	*5	3	—	5	5	18	3
United Steel Companies Ltd., Distington	—	—	—	—	—	3	1
Millom & Askam Hematite Iron Co., Ltd., Millom	2	2	—	—	1	6	—
Wilkinsons Hematite Iron & Steel Co., Ltd.	1	1	—	—	1	3	—
Totals	8	6	—	7	7	30	4

*Two furnaces making ferro-manganese etc.

North Staffordshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Midland Coal, Coke and Iron Co., Ltd., Apedale	2	—	1	1	2	5	—
Robert Heath & Low Moor, Ltd., Stoke	2	—	1	1	1	6	1
Hematite Iron Co., Ltd., Stoke	—	—	—	—	—	2	—
Goldendale Iron Co., Ltd., Stoke	1	—	1	—	1	4	—
Stafford Coal and Iron Co., Ltd., Shelton	2	—	—	2	2	4	1
Shelton Iron, Steel and Coal Co., Ltd., Stoke	2	—	—	2	2	4	1
Totals	9	—	3	4	6	25	3

South and West Yorkshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Walter Scott, Ltd., Leeds	1	—	1	—	1	2	1
Stocksbridge	—	—	—	—	—	2	—
R. Heath & Low Moor, Ltd., Parkgate Iron and Steel Co., Ltd.	*1	—	1	—	1	1	—
Newton, Chambers & Co., Ltd., Thorncliffe	2	1	—	1	1	3	—
Yorkshire Iron and Coal Co., Ltd., Leeds	2	—	2	—	2	3	1
Wm. Whitwell & Son, Ltd., Bradford	—	—	—	—	—	1	—
Totals	7	—	5	2	7	6	1

*Cold Blast.

Lancashire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Milburn & Askam Co., Ltd., Askam	—	—	—	—	—	1	—
Charcoal Iron Co., Ulverston (Backbarrow)	1	1	—	—	—	1	—
Barrow Hematite Steel Co., Ltd.	2	1	1	—	2	2	1
Carnforth Hematite Iron Co., Ltd., Carnforth	—	—	—	—	—	3	—
Barrow & Hindpool Iron Co., Ltd., Barrow	*1	—	—	1	1	2	1
Wigan Coal and Iron Co., Ltd.	—	—	—	—	1	1	2
North Lonsdale Iron and Steel Co., Ltd., Carnforth	2	2	—	—	1	2	4
Furness Coal & Iron Co., Ltd., Plank, near Ulverston	2	—	—	2	2	2	1
Totals	9	4	1	3	7	14	9

*One furnace making ferro-manganese, etc.
†Idle.

Derbyshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
Stanton Ironworks Co., Ltd., Alfreton	2	—	—	—	—	3	1
Barlborough Co., Ltd., Alfreton (Holmgate Walk)	—	—	—	—	—	2	—
Clay Cross Co., Ltd., Clay Cross	2	—	1	—	1	4	1
Denby Iron and Coal Co., Ltd., Denby	2	—	1	—	1	4	1
E. P. Lewis, Ironstone Works, Ilkeston	1	—	1	—	1	3	—
Renishaw Iron Co., Ltd., Renishaw	1	—	—	—	1	3	1
Shropshire Coal and Iron Co., Ltd., Chesterfield	1	—	1	—	1	3	—
Staveley Coal and Iron Co., Ltd., Staveley and Devonshire Works	4	—	4	—	3	13	1
Stanton Ironworks Co., Ltd., Ilkeston	4	—	4	—	4	9	1
Totals	16	—	16	—	14	42	6

Northamptonshire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
New Cransley Iron Co., Kettering, P. Phillips, Bunbury Hill Iron Works	—	—	—	—	—	—	—
United Steel Companies Ltd., Wellingborough	1	—	1	—	1	4	—
Islip Iron Co., Ltd., Thrapston	2	—	2	2	2	4	—
Kettering Iron and Coal Co., Ltd., Kettering	2	—	2	2	1	3	—
Wellingborough Iron Co., Ltd., Wellingborough	1	—	1	1	1	3	—
Lloyds Ironstone Co., Ltd.	3	—	2	1	3	3	1
Totals	9	—	8	5	8	21	1

South Staffordshire and Worcestershire.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
F. & J. Bradley, Ltd., Cannock	—	—	—	—	—	2	—
Bradley & Foster, Ltd., Darlaston	—	—	—	—	—	2	—
G. & R. Thomas, Hafford	1	—	1	1	1	4	—
Earl of Dudley, Brierley Hill	1	—	1*	—	1	4	—
S. Hingley & Sons, Ltd., Dudley	1	—	—	—	—	2	—
Alfred Hickman, Ltd., Wednesbury, Iron Co., Ltd., Wednesbury	—	—	—	4	4	4	—
Wilkinsons Iron Co., Ltd., Dudley	—	—	—	—	—	2	—
Baldwins, Ltd. (Neepsend Iron Furnaces)	—	—	—	—	—	2	—
Wm. Roberts (Tipton), Ltd.	—	—	—	—	—	2	—
The Birchill's Furnaces, Ltd., Walsall	—	—	—	—	—	2	—
Totals	7	—	3	4	6	30	1

*Cold Blast.

Gloucester, Somerset, and Wilts.

Name of Firm	Total in blast on Sept. 30	Out of blast Sept. 30, Waiting	Out of blast Sept. 30, Building	Average No. in blast, Basic	Average No. in blast, Forge & Foundry	Total built	Now relining
New Westbury Iron Co., Ltd.	—	—	—	—	—	2	—
Totals	—	—	—	—	—	2	—
Grand Totals for United Kingdom	138	47	74	27	129	1113	487

New Furnaces Building (17).

DERBYSHIRE (2):—Stanton Ironworks Co., 1, Sheepridge Coal & Iron Co., Ltd., 1.

SOUTH WALES (4):—Baldwins, Ltd., Ynysfeio Iron Co., Ltd., 1; Guest, Keen & Nettlefolds, Ltd., Dowlais Hematite Iron Co., 1; Lysaght, Ltd., Ebbw Vale Steel, Iron & Coal Co., 1; South Wales Co. (The Ebbw Vale Steel, Iron & Coal Co.), 1.

STAFFORDSHIRE (2):—Baldwins Ltd., 1.

LINCOLNSHIRE (2):—Appleby Iron Co., 2.

DURHAM AND NORTHUMBERLAND (1):—Bell Bros., Ltd., 1.

NORTH AND EAST YORKSHIRE (1):—Stanton Ironworks Co., Ltd., 1.

CUMBERLAND (1):—United Steel Companies, Distington, 1.

NORTHAMPTONSHIRE (1):—New Cransley Iron Co., 1.

SCOTLAND (1):—1 Dunlop & Co.

Number of Furnaces in Blast on Sept. 30, 1922.

District	Average No. in Blast, Basic	Average No. in Blast, Forge & Foundry	Total in Blast on Sept. 30	Total Building	Total Built
Scotland	18½	3	1	2	7
Durham and Northumberland	7	2	2	5	10
Cleveland	18	5	6	10	24
Northamptonshire	9	—	1	—	3
Lincolnshire	14½	10	—	3	13
Derbyshire	7	3	2	1	6
Notts and Leicestershire	3	2	—	—	4
S. Staffordshire & Worcestershire	4	2	1	1	4
North Staffordshire	4	2	1	3	4
West Cumberland	5	2	1	1	4
Lancashire	3	1	1	1	4
South Wales	7	1	1	1	4
South and West Yorkshire	2	2	1	1	3
North Wales	2	—	1	—	2
Gloucester, Somerset, and Wilts	—	—	—	—	2
Totals or Percentages	123	38	27	24	19
Totals for Previous Quarter	113	11	25	35	30

Average Number of Furnaces in Blast for the previous Six Quarters.

District	June, 1921	March, 1922	Dec., 1921	Sept., 1921	June, 1921	Mar., 1921
Scotland	12½	10½	16	6	—	5½
Durham and Northumberland	7½	9½	9½	4½	—	2½
Cleveland	18½	17½	15	5½	—	0½
Northamptonshire	9	6	4	—	—	—
Lincolnshire	12	12	13½	5½	—	2½
Derbyshire	7	7	5	1	—	—
Notts and Leicestershire	3	4½	3½	—	—	—
S. Staffordshire and Worcestershire	5	4½	3½	—	—	—
North Staffordshire	5	5	6	3½	1	—
West Cumberland	5½	5	5½	4	—	—
Lancashire	4	3½	4	—	—	—
South Wales	7½	7½	4½	—	—	—
South and West Yorkshire	3	2	—	—	—	—
North Wales	2	2	—	—	—	—
Gloucester, Somerset and Wilts	—	—	—	—	—	—
Totals	111½	99	88½	43½	1	20½

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Contents.

	PAGE
The French Congress Visit	353
The British Cast-Iron Research Association	354
Foundry Queries	354
Notes on the Development of the Manufacture of Steel Castings	355
The Art of Softening Cast Iron	358
Institution of British Foundrymen	359
Centrifugal Casting	360
An Apprenticeship Course in Foundry Practice.—XVI.	361
Book Reviews	363
Sheffield Foundry Trade Technical Society	364
Catalogues Received	365
Notes on the Heat Balance of a Cupola	365
Non-Scaling Furnaces	365
The "Watson" Electric Rotating Furnace	366
Grey Iron Castings—Their Chemical Analysis	367
Porosity and Surface Defects of Malleable Cast Iron	369
Trade Talk	370
Gazette	370
Manufacturers' and Merchants' Quotations	370
Iron and Steel Markets	372

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

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The French Congress Visit.

The reception to the appeal which we made last week, whilst distinctly encouraging, has not been up to the time of writing sufficiently general. We have received replies from just those people we expected to reply, the few people who shoulder the technical burden of the foundry world. It is pleasing to note that the first reply received by us was from Mr. H. L. Reason, the President of the Institution of British Foundrymen, who writes: "I was very pleased to read your article, 'An Appeal to British Foundry Owners,' in the current issue of THE FOUNDRY TRADE JOURNAL. I am inclined to think your suggestion will make a more successful gathering than if organised by the Institution, and for the sake of regularity have filled in the coupon." We look to the above to dispel any idea of non-co-operation with the Institution, and assume that this will be followed by official support after the next general council meeting.

Mr. J. Ellis, a past-president, has also written us. His letter reads: "Will you allow me to thank you for your leader in the current issue of THE FOUNDRY TRADE JOURNAL. To my mind it is another proof of the real live interest you are taking in the affairs of the foundry industry. I trust it will be approved of by all who have the interest of the craft at heart, and who wish to move with the times. I enclose the coupon."

We are afraid that a few people are holding back on account of our appeal being such a long period before the time of the visit. There are some very excellent reasons for this, outstanding amongst which is the assurance to the committee of the French Foundrymen's Association that their efforts are to receive adequate support from their British colleagues, and that the conference is to be truly International. Before our effort it appeared likely to be Franco-American-Belge. This we are particularly desirous of avoiding. There is another reason of equal importance with which we do not wish to deal in these columns, but which will be disclosed on our circular letter to those who show sufficient interest to fill in the coupon which appeared on page 16 of our last issue. The "Canadian Foundryman," dealing with the subject editorially, states "a real foundrymen's convention is assured, and there is no doubt but that many Canadians will avail themselves of the opportunity to have a trip across the Atlantic."

Amongst other facilities will be the taking over of all passport formalities and booking and hotel reservation troubles by the JOURNAL. It is hoped, should sufficient foundrymen decide to take advantage of our offer, to arrange for visits of two durations, the first of four days and the second to cover the full period of the exhibition and congress.

Whilst our appeal was made primarily to the owners, obviously it is open to any foundryman to join the parties. We deemed it necessary to go direct to the owner, as his co-operation is essential for the granting of facilities to others. We are aware that managers and foremen can arrange to take in a conference during their annual vacation, but a foundryman worthy of the name should be allowed something more than a busman's holiday. We pointed out that the expenses of the Americans will be paid by the American foundry companies, and similar facilities should be accorded to the British. However, there exist a number of managers, foremen and even those in minor positions who are sufficiently keen, not only to pay their own expenses, but also utilise their vacation for this purpose. For such people we shall be only too happy to cater, and to make every endeavour that their visit shall be a combination of pleasure and technical profit.

The British Cast-Iron Research Association.

Director of Research.

The Research Department, in its monthly circular, notes the appointment of Dr. Percy Longmuir, of Sheffield, as the permanent Director of Research, as announced in our last issue.

Progress of Research Work in Hand.

No. 2.—Moulding Sands Research.—Samples of standard foundry sands have been collected, and are being tested with a view of advising makers as to the suitability of different grades of sands for particular classes of work. The report fully detailing these tests is nearly completed.

Refractories Research.—It has been decided to commence the first joint research with the Refractories Research Association on ganisters for cupola repairs and hearth linings, and arrangements are well in hand with the work.

No. 3.—Internal-Combustion Engine Cylinder Castings Research.—Further cylinder castings have been examined and tested, and defects and causes of same investigated. Approved design castings will shortly be made for testing.

No. 7.—Malleable Casting Specification.—The Committee are obtaining further data preparatory to research work being carried out. A specification has been drawn up at the request of the Admiralty for malleable testing. This can be seen at the Association Bureau.

No. 8.—Shrinkage Defects Research.—Several experimental castings have been made, and extensive tests are being carried out, from which very valuable data and interesting results are being obtained in connection with "draws and shrink" holes in castings. These will be given in an interim report.

Cast-Iron Moulds for Die Casting.—The Association is taking an active interest in the proposed die-casting research about to be carried out by the Non-Ferrous Research Association, so as to be in a position to advise upon the cast iron for the moulds required.

Cast-Iron Moulds for the Glass Bottle Trade.—The Association are about to carry out an investigation in these moulds, as it is considered it will open out a new avenue of trade for the cast-iron industry. A report upon this will be sent to all members.

Wearing Properties of Cast Iron for Brake Blocks.—The Association are investigating this important matter. From the reports received there is no doubt that considerable assistance is required by the industry; at present there is no reliable information on the subject available.

Bulletin (Research) No. 2.—This is well in hand, and will be issued very shortly to the members.

Problems Received.

It is very gratifying to see that members are increasingly anxious to obtain the assistance of the Director in connection with their difficulties. Members are continually acknowledging the great value such assistance has been to them. The solution and investigation of many of the problems sent in have provided very valuable data and information towards the large researches in hand. The following problems have been reported upon during the past month, and will bo published in the Bulletin:—No. 144, Cast-Iron Moulds for Rubber Tyro Manufacture; No. 145, Defects in Cylinder Castings; No. 146, Cupola Practice; No. 147, Defective Flywheel Castings; No. 148, "Pitted" Flat Castings; No. 149, Loam Mixture for Acid Pot Castings; No. 150, Grey Iron Gear Wheel Castings; No. 151, Air Furnaces for Chill Roll Making.

The Bureau and Library Department.

Several new books have been added to the library during the past month. Tho "Intelligence Service" of tho bureau is being very much used by Members, and data and information on specific foundry problems have been applied for and supplied. Members aro reminded that they can borrow books from the library, which now contains over 400 volumes. The first Bureau Bulletin will shortly bo issued to Members and Associates, containing technical abstracts and other foundry data. The library catalogue is also being issued at an early date to all Members and Associates.

Membership.

During the past month seven foundries joined the Association. It is hoped that the membership will now very materially increase. The appointment of Dr. Longmuir as Director will, without doubt, enable the larger research work to be pushed forward, but the amount of work which can be put in hand depends entirely upon the support given by the industry. Foundry proprietors should therefore seriously consider as to whether they can afford to be deprived of the assistance which the Association is now giving to those foundries who are members.

Annual Meeting.

The annual meeting of the Association will be held in November, when some important alterations in the rate of subscription will be made. The election of the Council will also take place; under the new scheme arranged the new Council will be representative of every foundry district. The country has been divided into 16 districts, each area sending one member to the Council for every 100 foundries in that area. This will broaden out the interest of the Association, and give each part of the country a direct vote in its management.

Foundry Queries.

Stains from Aluminium Castings.

Query.—Can any of your readers give me information as to how to overcome stains on light coloured goods when they are pressed in aluminium shapes, heated by steam under pressure? We make "dishes" for pressing hats to the shape desired, and aluminium is preferred to the former cast-iron "dishes," which were too heavy. The trouble we encounter is staining of a bluish colour given out by the aluminium when heated.—T. D.

Answer.—There are several probable sources of this trouble, which is not a common one, and more information would be desirable to state definitely which one it might be so as to eliminate it. Very evidently some kind of chemical action is taking place, which would not be the case if it were really pure aluminium which had been employed with which to make the castings to form the "dishes" which are subjected to the heating, even of live steam. Of course, as most users of light castings do, it is likely to be an alloy of aluminium with some other metal, which has been used as it strengthens and stiffens the cast metal. Copper is the most generally used for this purpose, and if slight segregations of copper-rich portions are formed near the skin of the "dish," or even some of the slag included in the pouring, these are quite likely to be the cause of the trouble, for with the presence of moisture copper salts can be formed. and readily produce a blue or greenish stain, which would most likely pass unnoticed in coloured goods, but effectively mar the appearance of light-coloured goods. Another frequent admixture to aluminium to form an alloy is the metal zinc, and under the action of certain vapours arising from the steaming of dyed goods, they might also have a tendency to produce a coloration effect, but not usually of a blue colour. Then there is, of course, the possibility that the dye from some of the coloured goods may have acted on the alloy, but not likely on aluminium, to produce a discoloration which would not necessarily appear on the surface of the "dish," but be absorbed in any porous patch of the casting, and then be driven out later by the subsequent steam heating when applied to white goods. Thus a burnished surface of a purer aluminium alloy would most probably overcome the difficulty.—T. J. P.

A Postponement.

Mr. G. H. Judd's lecture on "Scientific Control in Motor Cylinder Foundries," which was to have been read before the Coventry Branch of the Institution on the night of the general election, November 15, has been on this account postponed to November 22.

Notes on the Development of the Manufacture of Steel Castings.*

By F. A. Melmoth, M.I.Britt.F.

The following notes are in reference to the production of light and medium-weight steel castings only, and are intended to constitute a rapid summarised description of various methods and operations in the production of such castings. No attempt has been made to labour any one point, as this would have unnecessarily prolonged the Paper, and the subject being of such immense scope, it appeared to the author that each of the various headings would in itself fully demand the usual space occupied by a Paper, if treated in a detailed manner.

Metal Manufacture.

Crucible.—Before the advent of the electric furnace quite a large quantity of light castings was produced in crucible steel, and there is no doubt that so far as the castings were concerned satisfactory results were obtained. Economic exigencies have now, however, almost cut out this method of steel production as applied to the manufacture of castings. The question of the difficulty of melting such low carbon material as is usually required in light castings has also affected the use of the process, and it has now been almost entirely superseded by the electric furnace or converter.

Converter.—Several types of this furnace exist, the general principle being the oxidation of carbon, silicon, and manganese from melted cupola-iron by the action of a blast of air suitably applied. The heat generated by the combustion of these elements is amply sufficient to give the resultant low carbon metal sufficient fluidity for the thinnest sections, and when properly made and correct additions of alloys added to the blown metal, a very suitable material for light castings is obtained. A modification of the usual side-blown or bottom-blown Bessemer converter was introduced some years ago, in which the actual melting of the pig-iron is carried out in the converter itself, instead of in a separate cupola, by means of oil burners, the fluid iron being afterwards blown in the usual manner.

The small size and general adaptability, coupled to the fact that extremely hot steel is obtained, make the stock a particularly good piece of apparatus for light castings.

Electric Furnace.—Many very efficient types of this furnace are now in constant use for steel production for light castings, and undoubtedly, given cheap supplies of scrap and current, they represent a fully proved and efficient melting medium for the purpose under discussion. The refining of the resulting metal, when made from impure scrap materials, can be quite easily and completely carried out, and the composition of the product is, in the author's opinion, more accurately under control than in the case of any other process used for the purpose. The refining can obviously only be carried out when the furnace is basic lined, but the uses of the acid-lined furnace are many, and assuming comparative steadiness in the composition of scrap material, remarkably successful results can be, and are, daily obtained.

Comparisons of Processes.

As previously mentioned, on the score of economy and owing to the immense strides made in the efficiency and knowledge of working of more modern types of melting plant, the crucible process for light castings has been quite superseded, only very few instances of its present use for the purpose being known to the author.

The metal obtained is no better, if as good, as that obtained much more quickly and economically by the other processes, and in the author's opinion it can be definitely left out of consideration. Competition between the converter and electric furnace for premier position as melting medium for light castings is severe, and is likely to remain so until progress has been made in the very much cheaper supply of electric current in large quantities, when the electric furnace, with its advantage of refining capacity and ease of control, should be able to triumph over what is under present conditions a particularly effective rival process. The question of relative fluidity, which is of extreme importance to the manufacturer of light steel castings, has been recently much debated, and the author agrees with those who believe the converter metal to possess greater fluidity at approximately equal temperatures than electric metal. One explanation given is that in converter steel the exothermic reaction of reductions of oxides by the finishing alloys is incomplete, and is progressing with a constant evolution of more heat during the casting of the metal, thus causing the steel to "live" longer. After carrying out a long series of experiments on this subject, the author is inclined to believe, however, that the explanation probably lies deeper, and may be associated with the actual solution of oxides in the liquid metal itself.

Charges in the electric furnace, when worked in different ways, vary most distinctly in fluidity, with identical compositions. Experiments are continually being made at the works with which the author is associated, with a view to obtaining fresh information on the controlling causes of this phenomenon, and many interesting facts have been noted. As large makers of small, thin, steel castings, most of which are made from electrically-produced steel, it is obvious that any means of increasing the fluidity of the steels will be eagerly sought after. One of the main criticisms of the ultra-pure electric mild steels which one hears is its inherent sluggishness, resulting in large percentages of short- and faint-run castings. There is no doubt, therefore, that definite conclusions as to the cause of this varying fluidity, and the discovery of a method of control would soon react favourably commercially.

Metal Composition and Influence of Impurities.

Except for very special purposes, light and medium castings are made from a straight carbon steel of a fairly low carbon. The usual physical specifications demand tensile strength within the range of 26 tons per sq. in. and 45 tons per sq. in. With an ordinary type of heat treatment these figures can be easily met by the following chemical specification:—

Range.	Carbon.	Silicon	Mang.
26 to 35 tons	0.18 to 0.22	0.25 to 0.30	0.6 to 0.7
35 to 40 ,,	0.28 to 0.32	0.25 to 0.30	0.6 to 0.7
40 to 45 ,,	0.35 to 0.40	0.20 to 0.25	0.6 to 0.7

On the question of the influence of such impurities as sulphur and phosphorus, opinions differ as to the safe amount of either or both which can exist in steel castings. In the case of sulphur, there is little doubt that an excess of this impurity causes hot cracks in the castings, particularly if they are of a complicated type. It is the author's opinion that 0.04 to 0.05 per cent. can be looked upon as a safe upper limit for high-quality work. The effect of manganese on the influence of sulphur should not be overlooked, and 0.6 to 0.8 per cent. of manganese is recommended. High phosphorus is often accused of being the cause of cracks in castings, and no doubt owing to its tendency to cause, when present in excessive quantity, a coarse, strongly crystalline structure in the cast condition, it becomes more likely that the heavy strains set up in the metal on solidifying will release themselves in the form of cracks, than is the case with a finer crystalline low-phosphorus steel. Up to a content of 0.06 to 0.07 per cent., however, very little effect is noticeable either in casting defects or the ultimate physical testing of the steel. With electrically produced steel the amount of the two impurities, sulphur and phosphorus, is so easily controllable that they need never be present in quantities sufficient to cause anxiety.

* A Paper read before the London Branch of the Institution of British Foundrymen on November 2.

The use of aluminium with a view to ensuring soundness has lead to serious trouble when carried to excess. Samples of steel castings have come to the author's notice which have broken very badly in service when subjected to alternating stresses and shock. In several instances it has been found that for some reason quite large amounts of aluminium have been used, the percentage actually remaining in the metal being very appreciable. The structure was coarse and open and in the worst possible condition to resist shock. Test-pieces specially made from the same charge, and treated with varying amounts of aluminium, afterwards subjected to the usual heat treatment, demonstrated the fact that when present in excess aluminium lowered both yield point and ultimate breaking load, reduced the elongation, and practically ruined the material for resisting shock. Titanium has been used as a deoxidising agent and found very good. It is not necessary, however, for steel castings, particularly if made from electrically produced steel. The effect noticed was a small but regular increase in the maximum breaking load and the yield point, with similar chemical composition.

Sands.

Most of the ordinary mixtures of sand are too well known to require detailing, and the main advance which has recently been made is in the utilisation of old sand. A prolonged investigation carried out between two or three years ago by the author at the works of Messrs. Braintree Castings Company eliminated to some extent the problems associated with already-used sands. It was found that the main cause of trouble was the accumulative increase in fine silt which occurs in steel-moulding sands on repeatedly using, which silt is very high in alumina. Its actual result was the gradual elimination of the porosity of the sand mixture, with obviously fatal results. By means of a patented plant which has been in use for two years, all these troubles have been overcome, and a very large proportion of renovated old sand is now used in all our facing sand mixtures.

Examinations and tests for grain size, along with regular estimations of moisture content, have ensured a complete regularity of product from our sand mills.

For green sand work, which constitutes the main bulk of light steel castings, various types of clays have been used as binding material. None has given such consistently good results as the Cornish type of sandy loam. Fireclays have been used, but the alumina content varies very greatly and also such facing sands have shown a distinct liability to dry on the mould face if allowed to stand, and to consequently crumble. A contributor to the discussion on Mr. Bradley's Paper on " Light Steel Castings " at the recent Birmingham Conference emphasised the point that too intense refractoriness in facing sands should not be sought after. The author is entirely in agreement from his own experience, but thinks that the explanation probably lies in the actual mechanism of " burning on." The theory that " burning on " is caused by the actual friction of the steel on the mould causing the loosening of particles of sand from the face, and its consequent entanglement in the surface of the steel, is put forward for consideration, and not primarily the influence of temperature on the facing sand. Obviously the higher the refractoriness of a facing, the higher its silica content and consequent friability.

In connection with sands for cores, a large number of proprietary binders have been tested, using sharp silica sand as a base. Oil and molasses mixtures have also been in everyday use. Good results have been obtained in almost all cases, but it is our opinion that oil and molasses has given the most consistently good finish. It has been found, however, that the temperature and time of baking are very important, as if this operation is not thoroughly carried out these cores are very liable to produce cracks. The reason for this appears to be that the molten metal has to carry out a portion of the baking on casting, thus increasing the time taken for the destruction of the bond and consequent collapse of the core. Low carbon steels setting so rapidly are in a semi-solid condition almost immediately after the mould is full, and in this condition are extraordinarily weak. It follows, therefore, that unless the core collapses very quickly indeed, hot cracks are inevitable.

Hand Moulding.

Light castings are obviously only a really commercial proposition in quantity, but in the present condition of the industry small quantities are frequently made by hand. For these small quantities which do not justify the expense of mounting for machine moulding, it is our practice where possible to utilise plaster or wood oddsides and employ boy labour for their manufacture, under the supervision of a skilled moulder. In a foundry laid out and equipped for the production in large quantities of light steel castings, small work of a jobbing nature would most probably not be accepted in normal times, and at the most would only represent a negligible quantity in comparison with the output of the machines.

Machine Moulding.

In the two works with which the author is associated examples of many different types of machine have been used, jolt ram, squeezers, hand-rammed turnover machines being in daily use during the last few years. For general use, these works have succeeded in obtaining most satisfactory results from jolt ram, pin-lift machines for small work. For medium work with deeper draught, jolt ram machines with turnover and pattern-drawing attachments have been used with very satisfactory results. Hand squeezers have given quite good results on shallow work, but have proved of little value where the depth of draw is anything considerable. In connection with all the above types of machines, the very great advantage of good metal patterns should be emphasised, not only on account of their durability, but also because of the undeniable fact that a far better skin has always been obtained from metal patterns than wood ones.

The author has not had the opportunity of actually seeing one of the new sand-slinging machines at work, but, judging entirely from the data examined, it appears possible that its introduction will entirely change our ideas in the future of what represents machine production. It is difficult to see how the question of keeping the sand in sufficiently good condition to be constantly used as facing can be arranged, as it appears practically impossible with this machine to use two sands, one for facing and one for backing. One absolute essential to the machine production of accurate high-quality small castings is an adequate supply of satisfactory moulding boxes. To ensure this the practice is to use steel boxes, machined on the joint, and, where special accuracy and freedom from even a suspicion of " crossed-joint " is demanded, the boxes are provided with hard steel bushes run into the box lugs with white metal. These boxes are frequently tested and, should any distortion have taken place, are re-machined and trued up. Should a new bush be occasionally required, it is only a few minutes' work to melt out the old one and run in a new one on a jig specially made for the job.

It has been found that there is a distinct liability for these boxes to distort, a great deal of it being due to rapping them when knocking out castings, the soft steel from which they are made bending and, of course, throwing out of position the pin holes. This necessitates a very rigid inspection of the box parts at frequent intervals. Apart from the question of weight, cast-iron boxes have been found very satisfactory. As practically all of these small boxes are handled by hand, the thickness was cut down to reduce weight, with the result that the percentage of broken boxes increased considerably.

After a considerable period, therefore, we have come to the conclusion that steel boxes frequently examined for distortion are the most satisfactory.

Dressing Shop.

Considerable advances have been made in appliances for dressing castings, and all modern shops are now fitted with such plant as sand blasts,

pneumatic chipping hammers, swing grinders, and so on. Band saw equipment where heads are easily accessible by saws, and acetylene cutting blow-pipes in other cases, have much reduced the time and expense in the removal of runners and

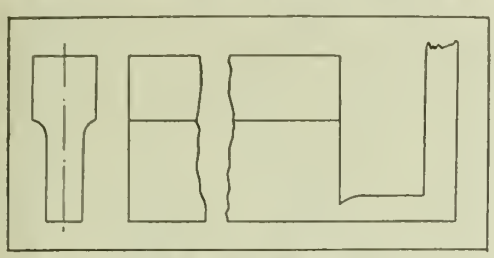


Fig. 1.—Standard Casting for the Preparation of Test Pieces.

risers. On light castings it has been found possible, by a judicious placing and shaping of the runners, to remove quickly and economically these by knocking off without detriment to the casting.

practice is merely to increase the time proportionately during which the castings are held at temperature, following with a slower cooling-down to a dull red, after which they can be cooled in air. Quenching in either oil or water, and tempering at a lower temperature subsequently, will also, where castings are called upon to perform special high duty, be found to produce remarkably good results.

Influence of Design.

The question of design from the foundry point of view is one which has been, except in a few outstanding cases, almost completely disregarded. Any complaint from a steel castings manufacturer appears to be taken, by the people concerned with design, as an admission of incompetence, and if the casting be made and not satisfactory, this is taken to be final proof of incompetency. Thick and thin sections, thick sections and bosses in inaccessible positions, heavy bosses attached to very thin general sections of metal, are happenings which constitute the daily lot of most steel foundry executives. Various methods are adopted, some-

Table I.—*Showing Results obtained for daily practice.*

Max. Stress Tons per sq. in.	Yield Point Tons per sq. in.	Elon. % on 2 ins.	Heat Treatment.	Analysis. C.	Si.	Mn.
30.46	19.8	34	900 deg. C. for 1 hr. Cool to dull red in furnace	0.18	0.23	0.75
29.76	18.72	37	do. do. do.	0.18	0.22	0.76
31.92	19.0	35	do. do. do.	0.19	0.30	0.72
28.0	17.1	33	do. do. do.	0.16	0.23	0.70
30.9	16.9	34	do. do. do.	0.24	0.40	0.69
32.0	23.4	32	do. do. do.	0.24	0.41	0.64
39.7	26.6	21	Quenched from 900 deg. C. in water and tempered at 550 deg. for one hour.	0.23	0.42	0.50
40.8	28.4	19	do. do. do.	0.22	0.33	0.74
40.8	28.3	25	do. do. do.	0.24	0.30	0.81

Welding.

Welding methods have been so much improved that in many cases castings which a comparatively short time ago would have been scrapped can now be quite satisfactorily repaired. The bulk of the welding which has to be done is more in the form of the removal of surface imperfections, and is done for the sake of appearance, but it is a fact that, judiciously used, the welding plant is capable of doing work of a much more ambitious nature. A properly-made weld, either electric or acetylene, possesses fully 80 per cent. the ultimate strength of the metal of the casting.

On the score of expense, electric welding is to be much preferred to acetylene, and is usually also considerably quicker.

times with complete and sometimes only partial success, to overcome the influence of such design, but there is no doubt that a much closer connection between the designer and the foundry which has to turn out in a particularly capricious metal articles of whatever shape and design he requires would result in castings more easily produced, a great saving in the cost of production, and an ultimately better product in service. These remarks obviously do not apply in all cases, and in the cases where the above conditions of mutual help exist, the effect on production and the satisfaction given are remarkable.

Testing.

The proportion of castings made to specifications, both physical and chemical, is most decidedly on

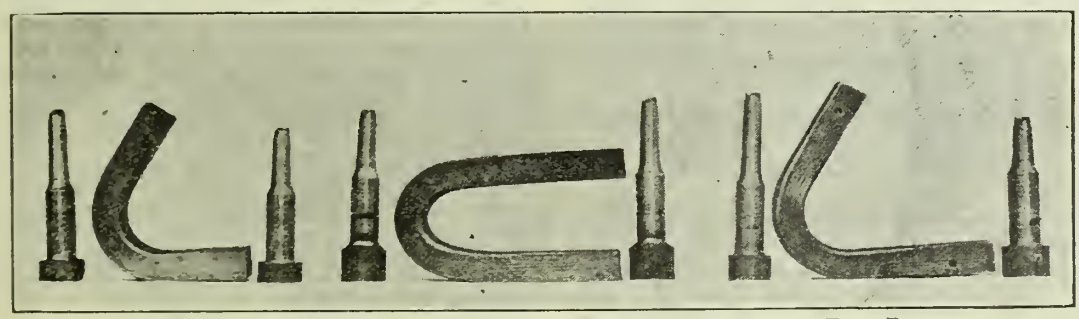


Fig. 2.—A Number of Standard Tensile and Cold Bend Test Pieces.

Heat Treatment.

For light castings there is no need whatever for a prolonged form of annealing, but the author is of opinion that, except in the very few cases where castings are not submitted to either shock or alternating stresses, it is very necessary to put them through some form of heat-treatment. The mild steels used for light castings, in particular the very pure electric steels, respond very quickly to heat-treatment and the structure and general properties obtained by heating to 900 deg. C., holding at that temperature for half-an-hour and cooling either in the furnace or in air, are, in any case, well worth the extra expense involved. For castings of a somewhat heavier type the author's

the increase, and consequently the modern foundry must be fully equipped to carry out the various tests required.

The best design of test block casting from which to cut the required bars is a matter upon which opinion varies, but, after a thorough trial of various types run in different ways, our standard practice is a block shaped, and run as shown in Fig. 1.

From this block several bars for tensile, bend test, etc., can be cut, and it is an extremely rare occurrence for any unsoundness to exist. The Brinell test is frequently specified, in which an impression made in the surface of the sample under test, by means of a hardened steel-ball

applied at a specified pressure, is measured and the hardness calculated from its area. This test is found to be very useful indeed, as on the mild steels used for light and medium castings, the Brinell hardness is almost proportional to the tensile strength, and consequently a rapid, cheaply-obtained control of the material passing through the shop can be very quickly obtained.

Impact tests have been carried out, but at present are rarely included in a standard specification. The results obtained with a V notch have always been variable, and, in the author's opinion, the U groove is far better and more likely to be consistent. Some tests carried out by a local metallurgist on the Guillery type of machine, using a bar with a U groove, were most consistently regular and satisfactory.

Fig. 2 shows a number of average tensile test bars after breaking, with their correlative cold bends. All these are from test blocks actually attached to castings made in each case from mild electric steel.

Table I. shows the results obtained in daily practice from standard test bars, the material being a mild quality of electric furnace steel.

General Remarks.

The whole position of the foundry, whether steel, iron or non-ferrous, has in the past occupied, apparently without very effective protest, far too low a position in the scale of manufacturing industries. The result of this has been to discourage the right type of person from a foundry occupation, with its inevitable aftermath, a shortage of really skilled, high-grade workers. It has been made to appear an industry of little opportunity, appallingly bad conditions, and as the last place to look if improvements were anticipated. During the period the author has spent specialising solely on foundry practice he has become convinced that, far from being the "Cinderella" of industry, as it is sometimes called, the amount of skill required by the successful artisan, the absorbing fascination of its difficulties, and the ever-present hazard owing to the great variation in the types of work demanded should, under proper conditions, fully justify the industry being placed much higher, and obtain for it an acknowledgment of its importance. This would certainly lead to the influx of a new type of youth, who would be able to retain for the industry that skilled artisanship for which, amongst those who know, the foundry trade is noted. In the newer foundries working conditions are infinitely improved, and if foreign competition is to be met and beaten, still further improvements must be made, so that, by means of a satisfied type of foundryman, feeling that his trade is one which is duly appreciated, allied to the benefits in production derived from the research work now being carried out on foundry matters to an extent never before equalled, the result may be a more economically-produced "better" casting, an ideal which all foundrymen will constantly strive for.

The Art of Softening Cast Iron.

By de Reaumur.

[In our issue of September 7 we gave a short bibliography of de Reaumur. His book on malleabilising iron has been reprinted and presented by M. Ramas at the Nancy Congress of the A.T.F. Bearing in mind that this was written some 200 years ago, it shows that the author was a keen observer and lucid thinker. Unfortunately no translation can do justice to his work. However, we have made a few extracts from his work, which we hope will give an insight into the type of work and reasoning accomplished at that period.—Ed.]

First Memoir.

The execution of elaborate work in wrought iron is almost prohibitive on the score of expense. In such work the rarer metals, copper for instance, have the advantage that they can easily be manipulated after casting. Owing to the difficulties of moulding, cast iron can only be used for simple decorative work, and it is of course impossible to forge it into more complicated forms after casting. A method is now being tried whereby cast iron can be made easily workable after casting, and experiments are in progress which suggest that the softening may be effected during casting.

Cast iron is generally considered in two classes—"white" and "grey," the class being determined by the manner in which the cupola is charged and worked and the subsequent appearance of the fracture. The fracture of "white iron" shows a close structure, there are no grains. The white of the whitest irons presents a "matt" surface, in which it differs from steel which shows a scintillating fracture. A rule, to which there are apparently no exceptions, is that the whiter the fracture the harder the iron. The whitest irons cannot be cut by file or chisel. The greyer irons, especially those approaching black, are readily filed. The whitest irons, too, are also the purest. Repeated re-melting tends to make a whiter iron. The aim of the experiments has been to render these white, hard irons soft and easily workable.

Second Memoir.

Reaumur's description of his furnace, in which the iron is in contact with the coke, shows the origin of the cupola. It is possible that, towards 1780, several cupolas were erected at Creusot by the English engineer, William Wilkinson. It can, however, be seen that the idea was originated by Reaumur, following experiments made about 1722.

Third Memoir.

Although the principal object in view was the softening of cast iron, another goal was the conversion of cast iron into steel. After some measure of success had been obtained in the first case—by embedding the casting in some material and re-heating to a suitable degree—it was temporarily abandoned to follow the second objective. Almost daily interviews were granted to people who pretended to possess the secret of softening east iron, but a little investigation shattered the hopes held out. Subsequent experiments showed that the two objectives were really the same thing. One of the most successful experiments resulted from the observation that an iron plate, after being in a fire for several days and the whole then cooled, was covered with a beautiful red powder, sometimes bordering on violet. This powder, which was simply burnt iron, was then used as the material in which the castings were embedded. The result proved that this gave a greater degree of softening than any other material in the same time.

Fourth Memoir.

In order to avoid burning of the charcoal dust, which is mixed with the calcined bones and scaling of the castings, it is necessary that the box or muffle in which the process is carried out should be airtight. The best form of muffle is long and narrow, in which the castings and the mixture are arranged in alternate layers. Natural draught is the best for the furnace, since the heating is then uniform and not localised as it is with forced draught. Arrangements are necessary to permit a view of what is happening in the muffles during heating. With the tall, narrow form of furnace wood makes the best fuel owing to the long flame. When increasing the capacity of a wood-fired furnace, the area of flues and height of chimney should only be increased sparingly in order to prevent waste of fuel.

Fifth Memoir (and Sixth).

If white irons, rendered filable by this method, are heated and quenched they will become harder, but can again be softened by re-heating in the mixture. The degree to which the softening process is carried determines the final state of the metal treated. If stopped at a certain point the cast iron has become steel; a later stage gives steel encased in iron, and finally—if the process is very prolonged—pure iron is the result. By repeating the treatment the original cast iron can be rendered so malleable that a thin test piece can be bent double under the hammer All experiments have shown that the whiter cast irons give the best results, and that the darker grey irons hardly answer to the treatment.

Institution of British Foundrymen.

SCOTTISH BRANCH.

The following are the office bearers for the ensuing session.

President, H. M. Hodgert (Paisley); Vice-Presidents, A. Lawrie (Hurlford) and J. Affleck (Cathcart); Hon. Secretary and Treasurer, W. H. Bound, 69, Minard Road, Shawlands, Glasgow; Members of Council, G. Mackay (Paisley), A. Mearns (Glasgow), A. Cree (Glasgow), H. Williamson (Kilbowie), J. A. Gardner (Kilmarnock), R. Robertson (Falkirk), D. McQueen (Falkirk), T. Bell (Barrhead) and A. Littlejohn (Glasgow).

Gating and Running Castings.

The first meeting of the session was held at the Glasgow Technical College on October 7. Mr. A. Lawrie, Senior Vice-President, occupied the chair. Mr. Lawrie, in opening the meeting, referred to the unavoidable absence of Mr. Hodgert, their president, who was prevented from attending through the serious illness of a member of his family. Mr. Lawrie declared the meeting open and called upon Mr. Thos. Bell, of Barrhead, to introduce a discussion on the subject of "Gating and Running Castings."

Mr. Bell at the outset stated that the success of a casting in a large measure depended on the position and size of the gates and risers.

The method of gating was a problem associated with production of every casting and although foremen were more or less responsible for every detail in the construction of a mould, their chief responsibility lay in deciding how the casting should be run. The gating of castings was like many other problems associated with the foundry, in so far, that no hard and fast laws could be laid down, every casting had to be considered independently and the opinion of many experienced foundrymen might differ regarding the method of gating the same casting.

Mr. Bell stated that the subject was one of great magnitude, he therefore wished to confine himself to the consideration of the gating arrangement for the marine engine cylinder shown in Figs. 5 and 6, in J. Varlet's description of the "History of Loam Moulding in the Province of Liége," described and illustrated in The Foundry Trade Journal of June 22, page 473.

Mr. Bell stated that the method of gating shown by Mr. Varlet may have been successful, but it was not the method he should adopt, nor was it the one commonly practised. His experience was that if it were run as shown in Fig. 6, the casting would show defects on the inside opposite the runners. He would prefer to have a large basin the full diameter of the cylinder, with spray gates at intervals of about 9 in. leading from the basin into an extension left on the top of the cylinder for the purpose of feeding the casting.

Plate Moulding.

This question served to create a considerable amount of interest as the subsequent discussion proved. The chairman then called upon Mr. Mackay to open a discussion on "Plate Moulding." Mr. Mackay at the outset stated that his observations on the subject of plate-moulding would be confined to castings made by hand from plates, the subject of machine plate moulding would be dealt with later by Mr. Bound.

The object of plate-moulding was to reduce the skill necessary for the production of castings by preparing the patterns in such a way that it obviates the necessity of making a parting or cutting runners.

Mr. Mackay stated that plate-moulding had been greatly developed since the introduction of moulding machines into the foundry, nevertheless the old method still held its own in many foundries at the present time. The lecturer wished to confine his remarks on plate work to the consideration of four articles of common use. (1) Sewing machine standards; (2) a mantel register; (3) a W.C. cistern; (4) a bath tub.

Sewing Machine Standards.

In proceeding with a plate-pattern for a sewing machine standard, a pattern was made as if the casting were to be made in the ordinary straightforward way. The next point to be considered was to prepare a wooden frame generally 5/16-in. thick and a little larger than the moulding box in which the actual castings were to be made, and prepared with snugs for the pins of the moulding box to pass through. The pattern and frame is then passed to a pattern moulder, who proceeds to select a moulding-box larger than the pattern of the plate-frame, he then moulds the pattern, makes the parting, and cuts the runners as in ordinary straight moulding. Before closing the top part of the mould the frame is placed on the drag and a wall of sand raised round the frame and made level with its top. When the top part is closed the joint of the box is open 5/16 of an in., a distance equal to the thickness of pattern-plate frame. Four pieces of iron plate 5/16-in. thick are inserted, one at each corner, to relieve the weight which otherwise would press on the wall of sand introduced round the pattern plate.

When the plate pattern is cast, it is filed up and holes bored in the snugs corresponding to the guide pins in the moulding box and then passed to the foundry.

The moulder who received the plate pattern places the cope part of the box on the floor joint upwards. The pattern plate is then laid in position, the drag is then placed on the top, the guide pins in the drag pass through the holes in the snugs in the plate pattern and then through the holes in the snugs of the top part.

The drag is then rammed up, the whole turned over. The top part is then rammed and a gate pin inserted at a position indicated on the plate. The top is then parted, the plate withdrawn, and when the top is again replaced the mould is complete. It will be noted in ramming the box the plate intervenes between the top and the drag, but when the mould is finally closed the plate has disappeared and the joints of the box now come together. The castings when turned out are an exact replica of the original pattern less two contractions.

Mantel Register.

Mr. Mackay's description of preparing a plate pattern for a mantel register was also most interesting, especially that part dealing with the method adopted for embossing ornament.

A description was given regarding the method of proceeding with a pattern for work of this type. The mouldings are run up in stucco and cast in an alloy consisting of 2¼ parts of lead and 1 part of tin.

After the mouldings are cast they are "chased" up with special tools and soldered into their respective position. As these castings are very thin they are built up on a pattern-board.

The mouldings at the centre of this casting usually terminate into an ornamental part at the top. This ornamental part is modelled in clay and a plaster cast is made, and from this solid plaster-cast, an embossed pattern is constructed. The method of procedure is that sometimes termed "the lost wax process."

The plaster block to start with, is in "reverse" and ordinary clay is rolled on a board to the thickness of metal required in the pattern, this clay is pressed gently into the ornament. The clay in turn is covered with stucco, and when set the stucco block is removed. When the clay forming the thickness is withdrawn, a runner or channel is then cut into the block, and into the space made by the removal of the clay is run liquid wax. The wax is obtained by melting down wax candles.

The wax impression now obtained has the ornament in its correct relief together with a body behind it equal to the thickness of the metal desired in the casting.

The wax mounted on the block, cast against the clay, is passed to the pattern moulder and cast in the lead-tin alloy already referred to. The casting is then returned to the pattern maker, who "chases" it with his special tools. When finished it is placed on the pattern board and soldered to the other parts of the pattern.

W.C. Cisterns.

An interesting description was given regarding the construction of a plate pattern for a W.C. cistern.

In the first instance a block is made to the exact shape of the inside of the cistern, this in turn is covered with sheet lead of a thickness equal to that required in the casting. The whole pattern is prepared as if to be made by the ordinary straightforward method. When complete it is passed to the pattern moulder, who introduces the " plate " in the process of moulding. When a name is wanted on the side of the cistern, a part is made loose at this point and drawn inwards before the main part of the pattern is withdrawn. The last illustration given by Mr. Mackay was no less interesting, this referred to the production of a plate pattern for a bath.

Bath Moulding.

In the first place an iron pattern for the bath is necessary, such a pattern is produced much in the same way as a W.C. cistern. A block is made to the inside size of the bath, then covered with sheet lead, the pattern for the roll is swept up in stucco, cast in lead and soldered to the main body of the pattern. When the iron pattern of the bath is passed to the moulder he selects two sets of moulding boxes, it may be mentioned here that the boxes for this type of moulding are made interchangeable and in three parts. The moulding box which is to act as the " plate " has the middle and top part fixed permanently. The iron pattern has a number of holes screwed to about $\frac{3}{8}$ in. dia. at intervals of 12 in. round the roll of the bath, and pieces of iron rods are fixed through the sides of the " plate " mid-part to within a short distance of the pattern to reinforce the cement to which reference will be made later.

The method of procedure is as follows :—

The iron pattern is placed on a pattern board and covered with an ordinary moulding box, the edge of the roll is made to line with the joint of the box, as the parting is made at this point. Rock sand is used for ramming up the construction mould, after the mould has been rammed it is turned over and the parting made in the ordinary way. An ordinary drag or bottom part is then rammed, rock sand being used as in the case with the other part.

As this is only a temporary mould, it should be rammed fairly hard. The whole mould is now turned over, so that the drag part rests on the floor. The middle and top parts are bolted together, parted, and turned over so that the top part rests on the floor. The pattern is lifted with the top and middle part. The " plate " moulding box is now brought forward, the combined mid and top part of the " plate " box is placed on the drag mould, and the drag part of the " plate " box is placed on the combined middle and top mould containing the iron pattern.

The $\frac{3}{8}$-in. iron rods are screwed into the holes at 12-in. centres around the roll of the bath. Rock sand is now rammed into the inside of the iron pattern to within 3 in. from the top of the roll. On the top of this is run common cement, the cement is brought up to the level of the drag and the iron rods screwed into the roll of the bath are embedded into the cement. In this way the iron pattern is securely fixed to the " plate " drag box. The other box, namely the combined mid and top part of the " plate " box, is also filled with cement. When the cement has set, which may take from 2 to 3 days, the original sand mould is removed. From one of the parts, the drag part of the bath mould is obtained and from the other part, the top part of the bath mould is taken, and when brought together forms the complete mould.

The descriptions given by Mr. Mackay were greatly appreciated.

Application of Moulding Machines to Plate Work.

Mr. Lawrie then called upon Mr. Bound, who gave a very interesting account of the application of moulding machines to plate work. Mr. Bound stated that one of the advantages of machine-moulding was the accuracy with which the patterns could be removed from the mould, in hand moulding a large amount of draw was demanded, whereas, in machine moulding 1/32 in. in 6 in. was considered ample. In machine moulding it was necessary to have all the boxes bored to jigs, aside castings were a thing unknown, and the boxes were interchangeable. The pins in the boxes were parallel for a distance of a $\frac{1}{4}$ in. only, and the holes into which the pins worked were lined with case-hardened bushes, having a clearance of 5/1,000 of an inch only. Cast-iron boxes were preferred owing to their rigidity.

At the close of the meeting Mr. Lawrie proposed a vote of thanks to Messrs. Bell, Mackay and Bound for their most interesting and instructive addresses, and this was heartily responded to by the members.

Centrifugal Casting.*

The author summarises the early history and gives a bibliography of literature and patents.† Mechanically, casting about vertical and horizontal axes are clearly differentiated. With a horizontal axis, distribution is symmetrical about that axis. With a vertical axis, the surface tends to be a paraboloid of revolution internally. In the De Lavaud process the spout moves as the casting forms; in other processes the entire charge to be cast is discharged so quickly into the mould as to form the article before it is chilled; this latter arrangement has resulted indifferently. For small numbers a clay mould in an iron container is indicated; for mass production a permanent mould. For this chrome-nickel or even cast tungsten seems a likely material. Where the moulds are initially hot (sometimes 1,095 deg. Cent.), they are inserted; where cool, they are part of the machine. Stresses require serious consideration; for this reason self-centring arrangements described by the author are deemed by him to be very important. Split moulds have to be used sometimes, and the author shows why bolts form quite unsuitable fastenings. The method recommended by him in lieu thereof is illustrated. Pieces more than 3 ft. long, and of thin section, in steel or monel metal, have only recently been cast successfully. This was due to using moulds too cold to allow occluded gas and slag to pass from the outside to the centre before the steel became too viscous to permit this. For the same reason contraction cavities are prevented if chilling is not too rapid. In steel and monel metal the walls harden entirely in 45-60 sec. if the mould is initially 1,870 deg. to 1,095 deg. Cent. The moulds are prevented from scaling by making them of nickel-chrome, or of tungsten; the latter has not yet been done on a commercial scale. The moulds are carefully cradled from furnace to machine, to prevent warping. To prevent alloying the hot moulds are protectively coated with kaolin, calcined magnesia, and the like, by a swab or air-gun.

For long, thin tubes of large diameter centrifugal casting is stated to be cheaper than Mannesmann methods and their modifications; probably also tubes so produced are less liable to corrosions having a stress origin. Large, thick tubing up to 24 in. dia. can be produced to compete with single-welded, and more cheaply than double-welded tubing. Very sound castings can be made thus of metals which cannot be " pierced " at all. The process presents a good opportunity for large plates to be rolled from the cast heat, *e.g.*, a split tube 20 ft. long, 20 in. dia., and 0.265 in. thick can be brought to 0.25 in. in one pass at an estimated cost of $4 per ton. Another application is to gears and special steels for chemical works (for the Claude and Haber processes). Good material and skilled and careful workmen are essential.

Two appendices are devoted to mathematical investigation of the forces involved in centrifugal casting and of the stresses in moulds, and another deals with the subject of temperature-control. Mathematically interesting is the suggestion that the number of revolutions for steel should be $N = 1{,}675$ over r where r is in inches to inner side of the casting. The indices form a valuable guide to anybody contemplating the method.—L. Cammen. (*Am. Soc. Mech. E.*)

Abstractor's Notes.—†This bibliography is not included in the advance proof.

* Institution of Civil Engineers, Abstract.

An Apprenticeship Course in Foundry Practice.—XVI.

By Ben Shaw and James Edgar.

CORE-PRINTS.

Cores and Core-prints.—The subject of core-prints is so intimately related to the general subject of cores and core sands that this article must be regarded as, in some degree, complementary to our discussion on this subject. It is not right to assume, as is frequently done, that cores are entirely the moulder's concern and prints the pattern-maker's. A comprehensive knowledge of the whole subject should be striven after both by young pattern-makers and moulders. The importance of correct core-prints cannot be exaggerated. We have already referred to the impracticability, in many cases, of making patterns that are a replica of the required casting, and the correct printing of a pattern may very considerably affect moulding costs.

Top Prints.

Top prints are always a danger when closing the mould. On the other hand, they are sometimes a convenience for venting. When the metal is very thin and there is not a substantial bottom bearance the top prints are useful for steadying the core. Top prints are in no respect a disadvantage for repetition work when the moulding is done on machines and the whole practice is precise and accurate. It is good practice to give top prints about 3-16th in. taper to the inch of depth and shape the core-box so that the core will be an accurate fit.

Circular Prints.

Circular prints are the common form of prints. Nowadays they are usually made on the sand-papering machine, but, until a few years ago, print paring was one of the first jobs of the apprentice patternmaker, and it is somewhat regrettable that it is not so still. Just as there are many mechanics who cannot use a cold chisel, so there are many patternmakers who cannot pare properly. Paring prints is splendid practice in the proper use of the woodworker's chisel.

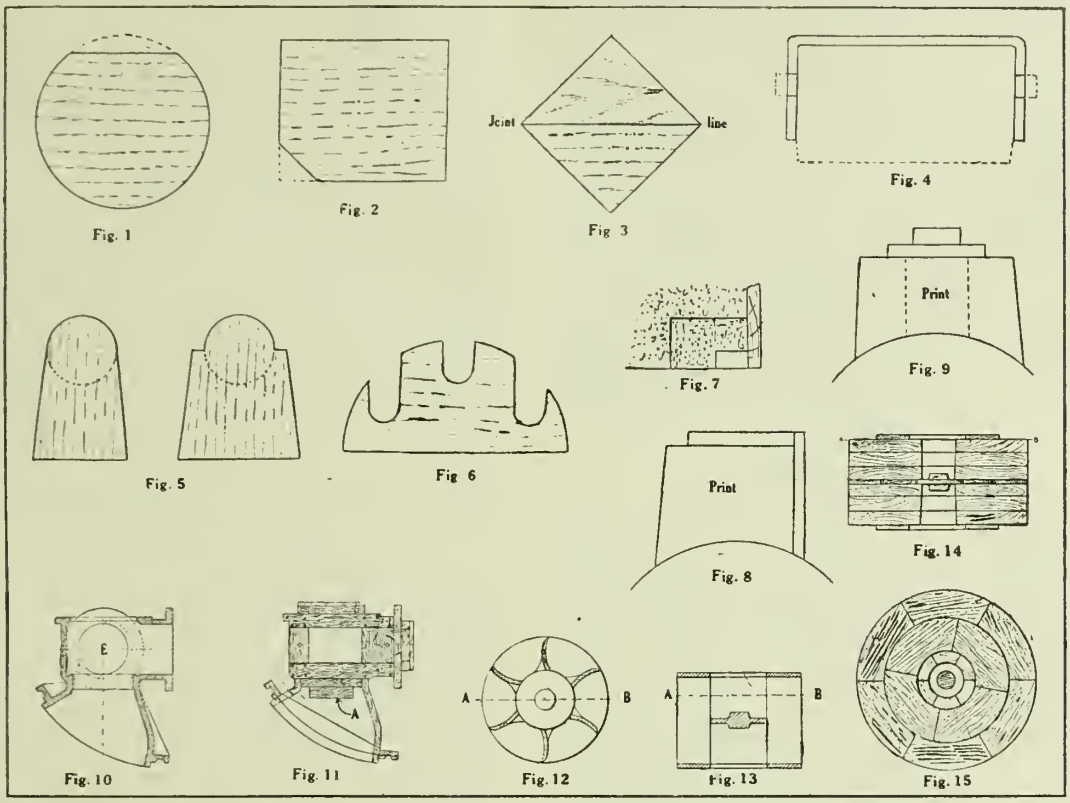


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig. 14 Fig. 15

Patternmakers' Knowledge of Foundry Requirements.

There is no greater test of the patternmaker's moulding knowledge than the correct printing of his work. It is not an uncommon thing in a jobbing foundry when a pattern comes in for the prints to be overhauled. The foundry pattern-makers' services are requisitioned, tail prints take the place of circular prints, some parts may be blocked up and cored out instead of being allowed to leave their own core, and top prints may be removed. In some cases a block-print may be attached to the pattern instead of a series of smaller prints, and a corresponding modification made to the core-box in order to give balance to the core, or holes through partition walls may be considered too small for venting purposes and the size of the prints need increasing. The pattern-maker may examine his work when it returns from the foundry, but it is not always possible for him to discover what alterations have been effected at the foundry, because, invariably, patterns are "put right" and sent back to the pattern shop exactly as they are supplied. Thus a pattern for a steel casting will often have innumerable ribs fitted between branches to help the flow of metal and equalise contraction, but these ribs are all stripped off before the pattern is returned, and so is it with regard to prints. A commonly disputed point, for instance, is the use of top prints. Are they or are they not necessary? Some pattern-makers do not differentiate between jobs; they make up for lack of knowledge by being extremely cautious, and the form this takes is to place prints on every opening in the walls of metal.

When the pattern is jointed horizontally circular prints should, in nearly all cases, be made in halves, as this assists the moulder very considerably when setting his core. Their thickness depends largely on the diameter of the print, and also on the shape and size of the core. A print may be a bearance or it may merely serve as a guide. If as the latter $\frac{7}{8}$ in. to 1 in. is sufficiently thick as a general rule. No taper is necessary on prints which are made in halves. In many cases, even when prints have to serve as supports for the core, it is not necessary to have exceptionally long prints, as the moulder may extend the length of the print impression to increase the bearance for the core. This is quite common practice when making odd lengths of pipe.

Taper.

Core-prints on the top or bottom faces of patterns should always be tapered, and providing that care is taken to make the core-box to the same taper as the print, the shaped print is an advantage. By shaped print is meant a print which is reduced in size to facilitate its clean withdrawal and the core-box shaped in a corresponding manner so that there can be no crushing either when the core enters the mould or when the cope part is

finally located. If unseasoned timber has been used or the print has not been accurately made the core will not fit properly, and the result will be worse than when the moulder has to rub the core to fit the print when closing the mould. Apart from shaping prints in the way mentioned, all prints that are not jointed across the centre line should be tapered. Some moulders prefer them to have their largest size as the core size, when the necessary taper is not allowed for in the making of the core; others like the smallest size of the print to be similar to the core. When the former practice is adopted the moulder has to card his core, and if this is carelessly done the result may be anything but satisfactory. Something can be said for each method, however, and the young patternmaker should fall in with the shop practice. Mistakes are probable when patterns coming from the same shop have prints made just as the patternmaker himself thinks best. Uniformity in shop practice is not always good, however, and it is manifestly absurd, as is the practice in some patternshops, to make all the prints of the same thickness, without regard to their size, position on the pattern, or core which they have to support.

Turning Prints.

With regard to circular prints, it may be accepted as a general rule that a large diameter print does not require as great a depth as one of small diameter. It is good practice, when it is possible, to turn prints that are of small diameter with a dowel, as they can be more accurately located on the pattern and their position is not easily altered in the foundry. Especially is this useful if many prints are required, because they can then be turned in a length on the lathe. A great advantage of such prints, apart from the accuracy by which they can be set, is that they always remain circular, such shrinkage as may occur being uniform around the diameter. The method is also advantageous in that it can be more readily removed for making up purposes and returned to its correct position on the pattern.

Balance Prints.

In many cases it is impossible to support cores with prints at both ends, and, while the moulder may be able to use chaplets, it is often desirable to make a heavy balance print so that the core will not require other support and to ensure that it will not move when casting. This applies to round, square, or irregular shapes. It is also frequently necessary, if the shape of a core is irregular, to shape the print and thus insure against any possibility of wrong setting of the core. With circular prints a flat is taken off, as shown in Fig. 1, and with square or rectangular prints the corner would be cut as at Fig. 2. The patternmaker is never justified in relying on the moulder's judgment, because the moulder has not the same opportunities for examining a drawing. Patterns should be made in such a manner that it is quite impossible for the moulder to go wrong. Time spent in the patternshop in correct and careful printing is more than compensated for by the time saved in the foundry. When making square or rectangular prints that have to be in halves, if it is possible to joint the pattern diagonally, as in Fig. 3, it is much easier for the moulder to set the core. This is not always possible, however.

When Prints are Advisable but not Essential.

Fig. 4 shows a design of a square casting with a large hole in the bottom-plate and smaller holes in the sides. Prints on the sides are not really necessary because the bottom print, the pattern being solid, supplies a good bearance. The objection to not printing the sides is that a fin of metal would probably be formed at the outer face, and if the moulder was not careful the core might be crushed while being placed. To obviate this prints might be used, and in all probability they would be made, for convenience both in making the core-box and the core, separately from the main core and set first. If they were not set before the main core it would be necessary to make a print reaching to the top face of the mould and a special core-box to extend the shape of the core. This form of print is called a tail, drop, or draw print. It is always better to use prints that leave a correct impression of the core when it is convenient to do so because the moulder can more quickly see the shapes of the various cores and better faces are ensured on the casting, because there are fewer sand joints.

Drop, Draw or Tail Prints.

Tail prints facilitate the setting of cores that would otherwise cause the moulder much trouble and involve the making of difficult joints. The commonest type of tail print is for circular cores. Here it may be stated that there should always be a considerable taper on the sides of tail prints. A tail print for a circular core may be made either as shown at A or B in Fig. 5. The advantage of the form B is that whether it is simply stopped over by the moulder or a special separate core is made for it, the impression is more easily filled. The form A is quite suitable when the tail core is made as part of the whole core. For a one off job it may be quite satisfactory to leave the stopping over to the moulder, but for repetition work a core-box should be made. As to whether it is better to make the tail core as part of the main core depends entirely on the job. If the core is large and the metal is very thin a separate core is desirable. It is also much easier, in many cases, for the patternmaker to make a special core-box than to cut the shape of the tail piece from the main core-box.

The thickness of tail prints depends, to some extent at least, on the thickness of metal to be cored and also on the size of the work. A common use of tail prints is in coring holes in pipe flanges. Frequently, to allow of slight adjustment when erecting pipe lines, square or rectangular holes are cored in the flanges instead of round holes, but whether they are square or round, the methods adopted for coring them are the same. There is a choice of three methods, viz., the flange may be made approximately double the required thickness, half of this being a print. When this method is adopted the print is sometimes made about 1 in. larger in diameter than the flange, and the moulder does not then need to fasten the core in position. The core-box is then made to full thickness of print and flange. Sometimes prints are not used at all, the cores being pressed into their correct positions with the aid of a template made about ½ in. thick and similar to Fig. 6. The tail print method is also quite common, the prints being carried to the joint or to the nearest part of the pattern in that direction.

Double Tail Prints.

Sometimes it happens that tail prints have to be made for two cores in the same vertical plane, but at different distances from the joint of the mould. There is no real difficulty involved when this is the case, as the top print is simply secured to the face of the bottom print, when it is intended that the moulder should fill up the tail impressions, or, for better class work, the one print to the position of the bottom hole is all that is required providing a core-box is supplied from which the full shape of the tail piece can be made, having the cores representing the holes projecting from it.

Facings on vertical walls of metal may cause difficulty in coring bolt-holes, especially if it is difficult to use a tail print on the facing side. In such cases the hole may be cut through the facing, the facing being wired on to the pattern so that it can be drawn into the mould after the pattern proper has been withdrawn, or a tail print may be employed, the print being made the thickness of the facing more than the core-box. In such instances the moulder should have a making up piece to form the complete shape of the facing when he is filling the tail impression; consequently it is better practice if at all possible to make a full core-box for the tail piece as well as the core proper, then the small part of the facing cut off by the tail print can be introduced in the box.

Block and Slab Cores.

Innumerable instances of external coring can be given, but the subject has already been well discussed. We shall confine ourselves here to a few examples for the purpose solely of explaining the printing. Sometimes slab cores are used by the moulder to support a body of sand, as when making moulding boxes. Supposing a flange is required to be cast at the bottom and about the outside of a box, and it is not possible to draw the pattern work into the mould for the sides, then the flange is fixed in a framed box. This is frequently done at the foundry. The box is generally made about 12 in. long, and as many cores are made in it as are necessary to go round the box. These cores are baked and then placed against the

pattern sides with the flanges removed and on a level bearance, sand can then be rammed about them, as shown in Fig. 7, and the mould proceeded with. Core prints are not always necessary, but they are, in nearly all cases, a great help. A core may be measured into position, and occasionally this is unavoidable.

Feet on the top of a cylinder pattern are frequently block cored, as in Fig. 8. If only one casting is wanted, or, if the shape on which the feet fit is very irregular, the pattern may be made a model of the required casting. As a general rule, however, it is better to build the ribs and flanges on a block which is well tapered and make a core-box to suit. For repetition, this should always be done. Some patternmakers adopt the same practice with top branches instead of turning a long print on the branch over which the flange fits or dowelling flange and print on the separate branch piece. One big advantage of this method is that there is less likelihood of errors occurring in the foundry. In loosening a foot or branch from the pattern during the time of ramming it may be rammed out of position. Fig. 9 shows a branch made with a circular print. The method does not entail much, if any, more labour in the patternshop, because there is less difficulty, as a rule, in fitting and it certainly facilitates moulding. The block print solves many difficulties, and it is much better to use them than to construct fragile patterns. When a design has to be altered after the pattern has been finished a print and core may overcome almost insuperable difficulties and prevent the pattern from being useless for the original design in the future. Variations from standard are very common in all patternshops. Then again in repair shops, castings are ordered and have to be delivered in such short time that there is no time in which to make a pattern. The casting must be used as a pattern, and either innumerable drawbacks and joints made or prints may be bedded against it in the sand and core-boxes made to suit.

Recess Cores.

On the machined faces of large jobs it is customary, instead of machining the whole surface, to have special portions recessed. We need not discuss why this is so as it does not concern the foundryman. As a rule the metal surface below the facings is all on the same plane and no constructional difficulties are presented, but sometimes one part is undercut and much labour is involved in reducing the surface. A print and core-box is one way of solving the problem, the thickness of the print being governed by the area of the core. Apart from the labour involved in undercutting a flat surface, if the pattern is boxed up of frames or plates it may be dangerously weakened.

In core-boxes for intricate cores there are often recesses which necessitate loose pieces or prints. Sometimes when parts are made loose it is nearly impossible for the coremaker to draw the parts, and a little foresight in the coring of such parts will generally result in a better casting.

Prints not Necessarily the Shape of Cores.

When prints are the exact shape of the core, as we have already said they form a useful guide for the moulder, but it is not in all cases advisable to shape them thus. Cores which break the wall of metal may be very irregular in shape, or there may be many different sizes, as in some bush cores. It may not be difficult to make the print to the core shape, but it may be decidedly awkward to fit a core into such a print, and the moulder may have to spend much time rubbing corners away. It is justifiable then to make the prints for irregular shaped cores as simple as possible. Many other instances might be cited of prints which should not be the proper size or shape of the core they represent. Whenever possible, of course, the exact shape of the core should be drawn on the pattern or print to guide the moulder. Fig. 10 represents a section of a circulating inlet valve used in ship construction and Fig 11 a joint view of a pattern. We shall not, however, concern ourselves with the pattern construction, but merely draw our readers' attention to the print A which is reduced in diameter to give sufficient sand between it and the shell part of the pattern.

Building Pattern on Print.

The pattern work for many delicate castings has all to be made in a core-box. Patterns which to the apprentice may appear very difficult because of their complicated design may be quite simple by making what is virtually a large print as pattern. Such a job is the pump impeller shown in Figs. 12 and 13. Both views are sections, Fig. 12 being on the line AB Fig. 13, and Fig. 13 on the line AB Fig. 12. The casting consists of a top and bottom plate with six vanes on the walls of metal between. To those curved vanes is attached a centre plate which is strengthened by connecting ribs. The metal may be only 3-16th in. or ¼ in. The sketches of the pattern Figs. 14 and 15 are almost self-explanatory. On a centre plate is built several courses of segments on which the top and bottom flanges are screwed. It will be observed that the print in this case has not been carried to the centre, but the inside diameter of both prints is well tapered. If the core were carried to the centre the moulders' work would be somewhat simplified, because he would then be able to part the mould on the line AB Fig. 14, but it is not as satisfactory "mitring" cores to the centre, and the small facings would be made up of six or more pieces of core, as only a sectional core-box would be made. An inch or even less is sufficiently wide for the print at the inside, but, at the outside, it may be two or even three inches thick. We are not dealing with core-boxes in this article, but it may be as well to state that the sectional core-box for this type of pattern would carry the pattern of one of the vanes, and when the cores are made and assembled in the mould the spaces for all the vanes would be left.

Accuracy in securing prints to their patterns is very important, and they should be very carefully checked afterwards, for, however accurate the cores may be, their correct position in their moulds can frequently only be determined by the impressions of the prints.

Book Reviews.

A Comparison of British and American Foundry Practice, with Special Reference to the Use of Refractory Sands. By P. G. H. Boswell, A.R.C.Sc., D.Sc. Published by Messrs. Hodder & Stoughton, Limited, Warwick Square, London, E.C.4. Price 4s. 6d. net.

Any information on sands, especially from the pen of Prof. Boswell, will always be welcomed by foundrymen. His book, "A Memoir on British Resources of Refractory Sands," is considered as a standard authority by British foundrymen, and the work under review is complementary to it. It is based upon his work when associated with the Ministry of Munitions and from his visit to America at their request.

Practical men will enjoy Chapter III., as it epitomises the question of sands in relation to foundry work, but it is Chapter IV. which supplies the information which foundrymen will appreciate most, as in the chemical specifications are indicated. Additionally, mechanical grading is set out on sensible lines, and its significance clearly outlined.

In Chapter V. the author outlines the principal properties of the various natural and artificial sands of the States. The comparison with British sands is particularly interesting, as the same methods of classification have been used in both countries.

The sixth chapter is devoted to bonding and furnace hearths, whilst Chapter VII., the last, is devoted to a general review and summary.

The author has kept the tables as a separate section, which is to be commended, as it renders comparison more easy. The plates, too, are also kept together. The book is well indexed. It should certainly be included in every live foundryman's library, as it constitutes a distinct contribution to the study of moulding sands.

Clyde & Company, Limited, importers of Diatomite (or Kieselguhr) for insulation, filtration, etc., have removed from Broad Street Buildings to 61, Fore Street, London, E.C.2.

Sheffield Foundry Trade Technical Society.

The first annual meeting of the Sheffield Foundry Trade Technical Society was held on October 18 in the Applied Science Department of the Sheffield University.

The following officers were elected for the ensuing year:—President, Dr. Percy Longmuir; vice-president, Mr. B. Wood; treasurer, Mr. R. H. Bowen; secretary, Mr. W. H. Bolton; assistant secretary, Mr. R. Barber; auditors, Mr. A. E. Hoyland and Mr. J. Watson. The following were elected on the Council:—Messrs. J. C. Barnsley, J. Porter, J. T. Goodwin, J. Shaw, A. E. Hoyland, J. H. Barnes, W. Waring, J. Emmett, T. Clark, and T. Gerretty. Three vacancies on the Council were reserved for members of the Patternmakers' and Engineers' Societies who are also members of the Foundry Trade Technical Society.

Aims of the New Society.

Dr. Longmuir explained for the benefit of new members the aims and objects of the society, which he said had been formed some time ago by Dr. Ripper, the head of the applied science department of the University. In all there were now some half-dozen of the trades of Sheffield in a technical society. These societies were intended to cater for a very large body of actual workers in a given trade who were not attending any technical classes and who were not in any established technical organisation. The objects of these societies were to rouse such an interest in their respective trades that the members would pass either into the technical classes provided by the Sheffield University or into the more established technical organisations. Speaking as one of the founders of the Institution of British Foundrymen and one of its Past Presidents, what he specially hoped to see was that society serving as a feeder to the Institution of British Foundrymen. He most sincerely hoped that its younger members would become evening students at the University and that they would take advantage of the facilities afforded by the University.

That was the foundry trades society, and therefore everyone connected with the trade, whether pattern-makers, moulders, core-makers, fettlers, or even engineers, were welcome as members.

Mr. W. H. Bolton, secretary, then read the rules of the Society, which were confirmed.

Dr. Longmuir's Address.

Dr. Longmuir, in the course of a subsequent address, thanked the members for having elected him as their President. He again referred to the aims and objects of the Society, and said they wanted to create a lively enthusiasm amongst the members for their trade. What was it they aimed at? They aimed at the expression of art, and the foundry trade represented one of the artistic sides of life. The skilful moulder and the skilful pattern-maker—the man who knew his job—was an artist in every sense of the word.

The programme which had been arranged included as speakers Messrs. Cook and Buchanan, both Past Presidents of the Institution of British Foundrymen, and they had, he believed, the sympathy of everyone connected with the development of the foundry trade.

Dr. Longmuir then addressed the meeting briefly on the subject of modern foundry practice, and illustrated his remarks with a number of lantern slides. The production of a casting, he said, was a work of art, and the general judgment of any casting, whether of iron, steel or brass, was to be found in its general balance of truth to pattern and its response to the test for percolation of water or some other test.

Dr. Longmuir then showed a number of slides indicating the composition of charges, the mould and its cores, method of melting, casting temperatures, presence of foreign matter, and shrinkage or contracting faults. These conditions, he said, summarised or typified the most essential things in determining the quality of any given casting. Proceeding, he explained the causes of contraction, and gave some general figures bearing on the subject. He next touched on the subject of expansion of metal due to rapid heating and cooling, casting troubles, fractures of antimony, chilled centres, the presence of blow holes, large crystals, etc., and, continuing, he said there was no study, in his opinion, more interesting than that of casting of moulds. At the age of 21 all of them knew a lot, but later on they discovered how little they actually knew. The more one attacked foundry problems, especially on the metallurgical side, the more one was convinced of all there was to be learned.

The Discussion.

Dr. Longmuir then called on Mr. Faulkner, the editor of the Foundry Trades Journal, "a paper which has served the foundry trades very well indeed," to address the meeting.

Mr. Faulkner said he felt rather nervous speaking that night on what was, after all, his native heath, because he had happened to be a student at that department of the University under Professor Arnold. The feeling was abroad, he said, in Great Britain that there was a distinct sphere for that Society, but he had heard the fear expressed in Sheffield that morning that that Society was going to disintegrate the usefulness of the Institution of British Foundrymen. He did not think so, because he looked upon it that that Society was going to make students in the foundry branch of trade sufficiently interested to come eventually into the ranks of the Institution of British Foundrymen, and in that way it would do good. He had been greatly interested in the address of Dr. Longmuir, and he thought the most interesting part of it was that in which he had referred to the subject of internal chill. German thought and British thought on that subject were at variance. British opinion was mostly that it was due to a wrong relationship between the manganese and sulphur, and in castings examined in this country it had been found that the manganese had been too low and the sulphur too high. It had been stated that the manganese should be four times the sulphur, and he believed that was a good proportion. But the Germans had found that when the manganese was more than covered by the manganese, still chilling would occur. Speaking generally on the subject, he thought that the old type of professor made things more easily to be understood by the student than the present-day generation, but Dr. Longmuir had given a good lead in that respect. He had made things very plain. If things were made difficult, he greatly feared a good many would be frightened off.

Mr. J. Shaw said that the majority of things which Dr. Longmuir had touched upon were established facts, but whether it was wise to introduce micography he candidly could not say. He was afraid, if there was too much of that type introduced, it would choke off some of the people they wanted to get there. He did not say it ought to be neglected, but he thought the subject might be taken by easier stages. He agreed with Dr. Longmuir that foundry work was interesting, and if he had his time over again, after 40 years' experience, he would not change. It was a dirty trade, a worrying trade, but if they got down to it they would find it most interesting. There was no other trade where the risks were so great.

A member from the body of the hall said he would like to have some more information with regard to the subject of blow holes. He was glad to hear Dr. Longmuir did not attribute all the fault for these to the moulder, and that responsibility sometimes rested on the mixture. He agreed with Mr. Shaw that the diagrams which had been shown were interesting, but he was afraid that, for a good many of the men present, they were rather difficult of understanding. For himself, he confessed they were quite beyond him.

Another member said he also agreed with what had been said with regard to diagrams. The fact remained that no man, whether he was the moulder or the foreman, could say what kind the casting was going to be and whether it was going to be a good one or not. That, of course, showed the very great care that was necessary if there was

to be a good casting. Dealing with the question of contraction, his experience was that there was considerably greater contraction upon manganese than in the ordinary classes of steel. He would be pleased to have further information on the subject of liquid contraction, and what would prevent it. All that showed how very little they knew when they were working on alloy steels.

Dr. Longmuir's Reply.

Dr. Longmuir, in the course of his reply, said he desired to thank Mr. Faulkner for attending that night. As they knew, he represented an organ on foundry work which he thought should be in the hands of everybody connected with the foundry trade. It had been his (Dr. Longmuir's) pleasure to write for that journal many years ago on foundry matters, and it was his good fortune in about 1904 to write in that paper an article which eventually clinched the formation of the British Foundrymen's Association, as it was then called—now the Institution of British Foundrymen. It was of interest to recall that the first meeting of that body was no larger than that meeting. That Institution had grown, and, as Mr. Faulkner had pointed out, that Association (the Technical Association) would in no way disintegrate the Institution. It would, he believed, to some extent feed it. He hardly knew how to refer to the question of internal chill at that time of night. He had raised it as a matter of curiosity. Generally speaking, however, as Mr. Faulkner had pointed out, when the manganese was four times greater than the sulphate, there was no danger of the internal chill occurring. He desired to thank Mr. Shaw for his remarks, and to admit candidly that it was difficult to frame that night's programme. He also agreed with Mr. Shaw that, whilst the trade was a dirty one, it was also one of the most skilful trades practised in the country. It was a trade which was never learned. With regard to the query with respect to blow holes, they could be due to the mould, and equally they might be due to the metal. On the subject of contraction, he pointed out that one got a varying contraction according to the various types of alloys. The figures he had shown were not meant to be specific, but general ones. He did not know any method of preventing liquid shrinkage, because most substances in cooling necessarily shrank. The boss on the plate he had shown would most decidedly influence the shrinkage. The question of casting temperature was an important one, and for that very reason he had not referred to it that night, but they would find in the proceedings of the Iron and Steel Institute certain references which would be useful and which were well worth reading.

The meeting then terminated.

Catalogues Received.

"The Better 'Oil'" (with apologies to Bairnsfather). This booklet is being broadcasted by Messrs. Spermoline, Limited, of Halifax. It has reference to core-making, and its intention is to reduce the "old Bill" for this department.

Arthur Gibson, Radnor Works, Twickenham.—This catalogue deals with Kinnear Patent Rolling Shutters, which are already well known to foundrymen as a novel means of closing drying stoves. They are also useful for closing foundry and patternshop doors and, being fireproof, should be useful for the purpose of dividing the two departments, where a careless designer has made them contiguous.

"Castings as an Engineering Material": Messrs. Dominion Malleable, Limited, Etna Works, Smethwick.

This brochure is of a distinctly interesting nature, and its object is to outline the physical and mechanical properties of castings of interest to those who construct machinery. It contains the analyses, mechanical tests, and usefulness of the firm's products.

The imports of foreign iron ore at the Lonsdale dock at Workington last week amounted to 970 tons. The outward cargoes for the week consisted of 2,830 tons of pig-iron, 1,150 tons of speigel and 600 tons of sleepers.

Notes on the Heat Balance of a Cupola.*

By J. Seigle.

The striking of a heat balance becomes particularly interesting when the kilogramme of carbon is taken as the basis, for then it is possible to set out the distribution of something that is absolutely known and fixed. There are definitely 8,080 potential calories in 1 kg. of carbon, and it is in accounting for the whole of these, instead of reckoning from 100 kg. of iron, that it becomes possible to compare a variety of heat balances. The factors involved are: (1) Potential heat in gas at outlet due to CO present in the gas; (2) sensible heat of the gas; (3) heat taken by iron and cinders; (4) losses through radiation, conduction, heating up of brickwork, and subsidiary reactions, such as the decomposition of the limestone, etc. Except for very accurate work, it is customary to ignore the small amount of CO_2 arising from the limestone, due to combustion of small amounts of Si., Mn., and Fe. The gases are considered mainly as CO_2, CO, and N. The heat losses through radiation, conduction, etc., can only be obtained by the difference between the 8,080 calories per kg. of carbon and the total of all the known items.

The heat carried away in iron and slag is calculated from the weight of each melted per kilogramme of carbon in the charge by the specific heat per kg. and their temperature. The specific heat is variously given as 0.21 to 0.27 for the two materials, though that of the slag may be 0.30 to 0.35. The temperature ordinarily taken is 1,250 deg. C. A heat balance alone, however, can give no indication of temperature; 100 kg. of iron at 1,300 deg. C. is entirely different from 130 kg. at 1,000 deg. C., although the number of calories is the same.

When the CO content of the outlet gases increases, the potential heat of the gas rises, and this evidently implies a loss of heat so far as combustion in the cupola is concerned.

Although the volume of the blast at any moment can be determined with comparative accuracy, the estimation of the effect of any variation is not an easy matter. By increasing the blast a greater quantity of C may be gasified, and there will perhaps be a greater volume of CO_2 in the outlet gases, but the sensible heat of the gases will also be raised, and it is difficult to say how far the increased calories are available for fusion. The great drawback is the impossibility of finding, otherwise than by difference, the heat losses, etc.

Non-Scaling Furnaces.

Messrs. Lucas Furnaces, Limited, of 45, Newhall Street, Birmingham, are acquiring larger works to cope with the demand for their Patent Antiscale Economiser Furnaces, the chief feature of which is the method of flueing-out the waste gases. These are utilised for heating the air for supporting combustion, and are so designed that no outside air can enter the chamber when door is opened; work can be obtained practically bright without any trace of scale or other bad effects. The manufacturers claim that though it is a natural draught furnace, there is a straigt-cut line of heat across the door-opening, when the door is open, the heat being uniform with the rest of the chamber. One firm are hardening steel blades in a furnace 24 in. wide and only 18 in. back to front with the door open, and are obtaining uniform heating and without scale.

It is stated that for pan annealing in open furnace several firms are obtaining practically bright results, doing away with pickling, and effecting a considerable saving in output over furnaces where work has to be boxed to get the same results.

These furnaces work best on towns gas or power gas, but are also supplied with integral producers for either solid fuel or oil.

Another interesting production is an oil core baking oven, built on the continuous principle, and heated on a novel system which is stated to give a perfect and economical result.

* Extracted from a Paper presented to the Nancy meeting of the Association Technique de Fonderie.

The "Watson" Electric Rotating Furnace.

No matter what metal is considered, rotation when liquid is beneficial. A wild dead-mild steel when cast in a spinning machine rotating at high speed has been known to give a perfectly sound bush. In melting in a rotating furnace there is the added advantago of having no slag line, and only one type of refractory, which is all equally heated. These features are distinetly advantageous. The latest rotating furnace to bo marketed has been designed by Mr. H. A Greaves, part inventor of the Greaves-Etchell steel melting furnaee, one of the few designs of British furnaces whieh has met with world-wide application. Messrs. Watson's Metallurgical Company, Limited, of Lancaster Street, Sheffield, have installed an experimental plant in their works for demonstration purposes. Up to now it has made, without ehange of lining (best fire-bricks), some 150 casts, ineluding ferro-manganese, cupronickel, brass, bronze, gun-metal, copper, cobalt ore, German silver, niekel silver, and Swedish horse nail scrap, as a base for making ferro-nickel.

The Furnace Proper.

The "Watson" furnace, as it is known, consists of a stout steel barrel lined with a suitable refractory material, and supported on rollers geared to a small motor. For rotating, the final drive from the rollers is purely frictional, of either teeming into preheated ladles or direct into ingot moulds on bogie wagons or conveyors.

Energy and Electrodes.

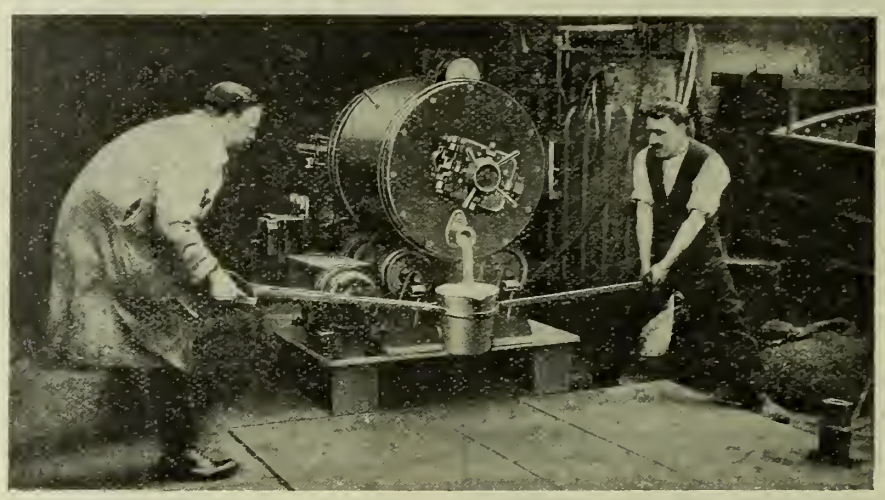
The electrodes only require occasional adjustment to maintain a constant energy input. They are each connected to a copper ring situated at the rear of the furnace. These rings collect the enorgy from spring clips.

Salient Features.

The outstanding feature of this furnace is its ability to work on any normal electric supply circuit, thus differing from some American patterns which require single-phase current. This necessitates three furnaces to balance a three-phase system. The furnace is so designed that it can be lifted bodily from the rollers and transplanted by crane for teeming in any part of the foundry. Associated with these the manufacturers claim (1) rapid melting; (2) perfect mixing; (3) sound metal without recourse to deoxidisers; (4) reduced metal losses; (5) low supervision costs; (6) low capital outlay; (7) small floor spaee; (8) definite temperature control up to 1,500 deg. C.; and (9) adaptability.

Capacity.

Two standard sizes have been designed for the brass trade, being 2 and 5 cwts. The former requires 50 and the latter 100 k.v.a. The smaller one melts 224 lbs. of brass per hour, using 280 units of electricity, whilst the figures for the larger are



The Watson Electric Rotating Furnace.

the weight of the superstructure and contents ensuring a steady movement. Suitable switch-gear is provided to enable rotation to be effected in either sense, and allows of full control of the teeming spout.

Heating Arrangement.

The neeessary heat for melting is furnished by an electric arc generated between two or more electrodes. This arc is magnetically blown into a large flame, which allows of an even distribution of heat throughout the furnace. This factor is also aided by the nearly spherical form of the chamber.

Process.

About 20 minutes after charging the furnace is rotated 20 degs. at intervals of oue minute. As soon as a good bath of metal is formed the furnace is slowly rotated, the metal then absorbing an excess of heat in tho lining above the bath. Continued quieker rotation obviously prevents any ovorheating of any portion of tho chargo due to tho constant and thorough mixing which takes placo. Volatilisation can be thus definitely attributed to the operator and not tho furnace, as obviously the metal should bo cast before tho whole is so excessively heated.

For teeming the furnaco the top hole is brought below the slag line, and a stopper and nozzlo filled to the teeming spout is opened by serewing outwards. The advantage of this is that the flow can be regulated to a nicety. This design allows 500 lbs. and 250 units. A metal loss of 0.5 per cent. is also claimed.

Costs.

The estimated cost of melting a ton of metal is set out in the following table:—

	2-cwt. Furnace. £ s. d.	5-ewt. Furnace. £ s. d.
Electricity at 1d. per unit	1 3 4	1 1 8
Electrodes at 1s. per lb.	6 0	5 0
Labour	1 0 0	12 0
Furnace repairs ...	2 6	1 6
	2 11 10	2 0 2

Mr. Charles Ford, mineral, coal, pig-iron, and steel merchant, has removed to 196, Bishopsgate, E.C.2.

The report of Mr. F. W. Harbord to the New Zealand Government on the production of pig-iron and steel from New Zealand ironsands has been presented in the House of Representatives. The report expresses the opinion that the conditions in New Zealand are such that a blast-furnace and modern steel plant are not at present feasible, but if power, coke, coal and limestone were obtainable at reasonable prices small quantities of pig-iron and steel might be produced to meet local requirements partially, this forming the basis for building up a larger industry when the demand increased sufficiently to justify operations on a larger scale.

Grey Iron Castings—Their Chemical Analysis.*

By Dr. Richard Moldenke.

In working out problems in machine design the mechanical engineer is constantly confronted with requirements for those parts he wishes to make of cast iron which make it necessary for him to be informed upon the latest developments of the foundry industry. Where to use a casting and what metal or alloy to make it from should be pretty well known by now, but what class of cast iron to use and what kind of a foundry to get it from may be matters open to doubt in these days of rapid changes.

Cast iron, with all its lack of homogeneity and consequent requirements of large factors of safety, is nevertheless of such variety in physical properties that few engineers are familiar with the many uses to which it can be put satisfactorily. It may run from glass-hard to dead-soft, from a condition of brittleness to one of considerable toughness and elasticity, appear silvery to black in fracture, may be made acid-proof and also yield to acid attack promptly; and, strange to say, may exhibit some of these diametrically opposite properties in the same casting. Therefore, even though he depends upon the foundryman to deliver him the kind of casting he needs, the engineer should have some knowledge of the underlying causes for the peculiar properties exhibited by cast iron when put into the form of castings.

The Carbon Situation in Cast Iron.

To understand the nature of the complex material known as cast iron it is necessary to go behind the returns of an "ultimate analysis," as it were, in order to get the "rational" analysis, or the grouping up of the several elemental constituents. Here it will be seen that the total carbon is present in two forms, part of it being a mechanically mixed crystalline graphite and the remainder being chemically combined. Then there are iron silicide, phosphide and sulphide, the last two compounds being distinctly crystalline when present in comparatively large proportions.

The amount, distribution and physical condition of the graphite thrown out of solution at the moment of set are the more particular items of importance to the engineer in connection with the strength and machinability of the casting. While the total carbon of the metal is the same throughout the mass, the division into mechanically mixed graphite and combined carbon will be such that the highest proportion of the former will be found in the centre of the section together with the least of the latter form, and vice versa at the periphery. Since the presence of combined carbon in increasing proportion means a corresponding increase in hardness, the metal at the surface of a casting will be harder than in the centre. Further, the oxide of iron formed through contact of molten iron with a damp mould surface and the fluxes in the moulding sand if not properly covered with adhering graphite, on interacting form an enamel which is very hard on the cutting tool, and hence this should be made to dig under the skin of the casting and lift the surface metal away as it cuts along under lubrication of the graphite present, and not be allowed to glide over the skin.

With the foregoing explanation of the carbon situation in cast iron, and remembering that graphite is in mechanical admixture only and consequently is an element of weakness by cutting up the continuity of the iron mass, it will be understood that fundamentally cast iron is a steel of given combined carbon content, with the other elements present in much higher percentages than one would expect in any steel. For instance, if the percentage analysis of the chips taken from the first eighth inch below the surface of a flat plate gave silicon 2.00 per cent., manganese 0.70 per cent., phosphorus 0.45 per cent. and sulphur 0.12 per cent.: with graphite 3.20 per cent. and combined carbon 0.30 per cent.: then that part of the plate was for practical purposes a 0.30 per cent. carbon steel containing much graphite, double the usual sulphur and ten times as much phosphorus as a steel ought ordinarily to contain. The analysis for the carbons is advisedly given as representing the first eighth inch of the flat plate, and not the whole of the plate, as would be the case for the other items of the analysis. The fact that the proportions of the two forms of carbon vary from surface to centre conclusively shows that while the total carbon of a cast-iron analysis may be perfectly reliable, the items "graphite" and "combined carbon" in such an analysis are worthless unless the actual point from which the sample has been taken is indicated.

Considerations Regarding Chemical Composition of Castings.

So far as the chemical composition of cast iron is concerned, it may be said that silicon as the chief determining factor of the condition of the carbon present may run from as low as 0.35 per cent. in deeply chilled castings up to 3.25 per cent. in the very lightest of hardware and novelty work. The absence of silicon allows the carbon to remain in chemical combination with the iron. As the percentage of silicon increases the iron loses its power to hold the carbon in combination and it is thrown out as graphite at the moment of set. The higher the silicon, the greater the graphite percentage. A factor affecting the silicon content to be employed is the rate of cooling of the metal when a mould is filled with molten iron. The thinner the section the greater the power of the iron to hold the carbon in chemical combination in spite of the silicon present. Hence high silicon is necessary to prevent thin sections from turning out hard, and since the foundryman must deliver his castings in condition to machine properly, he naturally regulates the silicon of his mixture to care for the thinnest section. He has the further difficulty of contraction with which to contend. Cast iron with the carbon all combined—or "white iron"—has a casting contraction of $\frac{1}{4}$ in. to the foot, whereas with the carbon all as graphite this contraction (erroneously called "shrinkage") is only half as much. If the foundryman were to aim for strong iron with a reasonable machinability for the heavier sections of the casting to be made (the blueprint showing that these sections go under the planer, etc.), making his mixtures accordingly with high steel-scrap percentages and comparatively low silicon, the thin rib and brackets of the casting would come out hard and brittle, if not actually white in fracture, and the greater contraction of these in cooling from the molten state would cause bad warping and internal strains. The mechanical engineer should therefore study the metallurgical side of the foundry requirements so that he may design his work with the least abrupt changes in section, avoid sharp corners and distribute his metal to the best advantage—in other words, give the casting a chance.

The total-carbon percentage has come to be a most important factor in the iron-casting industry. Of recent years the comparatively low total carbon iron made in the air furnace, and called "gun iron" from its use previous to the days of the steel cannon, has been paralleled by cupola metal in which great quantities of steel scrap are added to the mixture. Even in the air furnace the former long periods of refining to reduce the total carbon are shortened by adding all the way up to 30 per cent. of steel scrap to the mixture of pig irons and home scrap. The product gets the erroneous name of "semi-steel" from those who are not informed on the properties of this grade of cast iron—for it is only a high-grade cast iron, with none of the properties of steel. Its importance to the engineer lies in the fact that the ultimate strength is nearly doubled by adding the steel scrap, and that the comparatively cheap iron casting need not be replaced by the more expensive cast steel. The foundryman, however, has a problem before him in running these high-steel-scrap heats. Only the best cupola and mould-gating practice will yield castings free from blowholes, cracks and serious internal shrinkages. The silicon percentage must

* From the "Canadian Foundryman."

be watchod particularly, so that separation of graphite and combined carbon may leave the latter low enough for proper machinability. The effect of low total carbon (it may be brought down to 2.25 per cent., or just above the line of division into steel), if the combined earbon is kept normal, is to give an otherwise lower graphite percentage. Necessarily this graphite is finer in crystallisation, and there being less of it than normal, the planes of separation in the solid metal are smaller and fewor, hence the greater strength. Moreover there is much less phosphorus present as the result of the low phosphorus of the steel added.

Manganese in the castings should not be allowed to run below 0.50 per cent. nor over 1.00 per cent. for normal machinable work. Phosphorus should be as low as possible, considering the pig irons that must be used, and for important and thick work had better run below 0.40 per eent. Very thin castings, such as art and architectural details in structures—which really correspond to the " stove plate " of the foundryman, require very nearly

the country building heavy machinery and engines (particularly of the marine type). Castings to withstand high pressures, such as those of air, steam and ammonia, are made by foundries specialising in air compressors, pumps, refrigeration machinery, and the general valve and fitting trade. For light parts to serve for ornamental purposes thero are many stove shops to which recourse may be had. In general, however, where reciprocating parts or sections of intricate eharacter and subject to severe strains are required, it is safer to go to the large concerns making well and favourably known lines of product. The foundries connected with such establishments have the proper facilities and the trained men to undertake the work, and will be in a position to advise improvements in design to give the metal a better chance for the purpose intended. Foundries of the class just mentioned usually have need of several mixtures of iron to supply the parts required for the line of machinery turned out. Hence they usually run a few

Table I.—*Recommended Analyses for Various Classes of Castings.*

Castings	Light					Medium					Heavy				
	Si	Mn	S	P	T.C.	Si	Mn	S	P	T.C.	Si	Mn	S	P	T.C.
Acid-resisting	2.00	0.75	0.05*	0.20*	3.25*	1.50	1.25*	0.05*	0.20*	3.25*	1.00	1.25	0.05*	0.20*	3.25*
Agricultural	2.50	0.60	0.06	0.75	3.75	2.25	0.70	0.08	0.70	3.50	2.00	0.80	0.10	0.60	3.25
Air cylinders	1.90	0.70	0.08	0.50	3.40	1.50	0.80	0.09	0.40	3.25	1.00	0.90	0.10	0.30	3.00
Annealing boxes	—	—	—	—	—	0.65	0.20	0.08	0.20	3.50	—	—	—	—	—
Automobile cylinders	2.25	0.65	0.08*	0.40*	3.25*	2.00	0.75	0.08*	0.40*	3.25*	—	—	—	—	—
Balls for grinding	—	—	—	—	—	0.75	0.50†	0.15*	0.40*	3.75†	0.50	0.50†	0.15*	0.40*	3.75†
Bedplates	2.00	0.70	0.08	0.60	3.75	1.75	0.75	0.10	0.50	3.50	1.50	0.80	0.12	0.40	3.25
Boiler castings	—	—	—	—	—	2.00	0.80	0.06*	0.20*	3.50*	—	—	—	—	—
Car wheels	—	—	—	—	—	—	—	—	—	—	0.65	0.50	0.08	0.35	3.50
Chilled castings	—	—	—	—	—	—	—	—	—	—	—	1.00	0.06*	0.20*	3.50*
Chills	—	—	—	—	—	1.00	0.50	0.05	0.20	3.00	—	—	—	—	—
Crusher jaws	—	—	—	—	—	1.00	1.00	0.04	0.20	3.50	0.80	1.25	0.06	0.20	3.25
Dies for hammers	—	—	—	—	—	1.50	0.60	0.05	0.20	3.00	1.25	0.80	0.06	0.20	2.75
Dynamo Castings	2.50	0.50	0.05	0.75	3.75	—	—	—	—	—	2.15	0.50	0.06	0.50	3.25
Electrical work	3.00	0.50	0.03	0.60	3.75	2.75	0.50	0.05	0.50	3.50	—	—	—	—	—
Engine frames	—	—	—	—	—	2.00	0.60	0.08	0.50	3.50	1.75	1.00	0.10	0.40	3.00
Fire pots, grates	2.25	0.60	0.05	0.20	3.50	2.00	0.80	0.06	0.20	3.25	—	—	—	—	—
Fly wheels	2.00	0.50	0.05	0.50	3.50	1.50	0.60	0.06	0.40	3.25	1.25	0.70	0.08	0.30	3.25
Friction clutches	2.40	0.60	0.10	0.70	3.75	2.00	0.70	0.12	0.50	3.50	—	—	—	—	—
Furnace castings	2.40	0.60	0.05	0.60	3.75	2.15	0.80	0.06	0.50	3.50	—	—	—	—	—
Gas-engine cylinders	2.00	0.70	0.08	0.40	3.25	1.50	0.80	0.09	0.30	3.00	1.25	0.90	0.10	0.20	2.85
Gears	2.25	0.60	0.08	0.70	3.75	2.00	0.80	0.09	0.60	3.50	1.50	1.00	0.10	0.50	3.25
Glass moulds, pipe balls	—	—	—	—	—	2.50	0.60	0.04	0.20	3.25	—	—	—	—	—
Grate bars	—	—	—	—	—	—	0.60	0.05	0.20	3.50	—	—	—	—	—
Gun iron	—	—	—	—	—	1.50	0.50	0.05	0.30	3.25	1.00	0.60	0.05	0.30	3.00
Hardware	2.50	0.70	0.08	0.80	3.75	—	—	—	—	—	—	—	—	—	—
Heat-resistant iron	—	—	—	—	—	2.00	0.80	0.06	0.20	3.25	1.50	1.00	0.06	0.20	3.00
Hydraulic cylinders	—	—	—	—	—	1.50	0.80	0.05	0.40	3.25	1.00	1.00	0.08	0.20	2.85
Ingot moulds	—	—	—	—	—	—	—	—	—	—	1.25	0.80	0.06	0.20	3.75
Machinery castings	2.50	0.60	0.08	0.70	3.75	2.00	0.80	0.09	0.60	3.50	1.50	1.00	0.10	0.50	3.25
Mine wheels	—	—	—	—	—	0.90	1.00	0.10	0.20	3.00	—	—	—	—	—
Ornamental castings	2.75	0.60	0.06	0.90	3.75	2.25	0.70	0.08	0.80	3.50	—	—	—	—	—
Pipe (water)	2.25	0.60	0.06	0.80	3.75	2.00	0.80	0.08	0.70	3.50	1.50	1.00	0.10	0.60	3.50
Piston rings	2.00	0.70	0.05	0.60	3.50	1.75	0.80	0.06	0.50	3.25	—	—	—	—	—
Pulleys	2.40	0.50	0.05	0.70	3.75	2.15	0.60	0.07	0.60	3.50	1.90	0.70	0.09	0.50	3.25
Radiators	2.25	0.70	0.06	0.80	3.50	—	—	—	—	—	—	—	—	—	—
Rolls (chilled)	—	—	—	—	—	—	0.80	0.06	0.40	3.25	—	1.00	0.08	0.30	3.00
Soft castings	2.60	0.50	0.06	0.60	3.75	2.40	0.60	0.08	0.50	3.50	—	—	—	—	—
Soil pipe	2.25	0.60	0.08	0.80	3.75	2.00	0.80	0.10	0.60	3.50	—	—	—	—	—
Steam cylinders	2.00	0.60	0.08	0.50	3.50	1.60	0.80	0.09	0.40	3.50	1.25	1.00	0.10	0.30	3.50
Stove plate	2.50	0.50	0.06	1.00	3.75	2.25	0.60	0.08	0.80	3.50	—	—	—	—	—
Valves	2.25	0.60	0.07	0.50	3.25	1.75	0.80	0.08	0.40	3.00	1.25	1.00	0.09	0.30	2.85
White iron castings	—	—	—	—	—	0.75*	0.20†	0.25*	0.75*	2.50†	—	—	—	—	—

* Below. † Above.

1.00 per cent. of phosphorus to come out in perfect detail. Table I. gives recommended composition of castings for many purposes. It is not wise for the engineer to specify the chemical eomposition of the castings he requires, but if strength is important it should be specified in the States according to the standards of the American Society for Testing Materials.

Specialising in Iron Founding.

The foundry industry is pretty well divided up into specialised lines of work. If the engineer needs chilled castings he turns to the makers of chilled rolls. Many foundries, however, other than roll makers produce crusher castings, balls for grinding, and shoes and dies for stamp mills. Another important braneh of foundry work is the making of cylinders. For the highest grade, foundries having air furnaces should bo selected, particularly if they make a speciality of cylinders, piston rings and the like, and theso will be found among the great foundry and machine works of

charges of fairly low-silicon, high-steel-scrap metal for such eastings as air-compressor eylinders, rolling-mill parts, and other work of high strength and density. The next eharges may then care for ordinary machinery castings, and finally a few extra soft or high-silicon charges may eare for pulleys and the very light-section product. Sometimes the process is reversed, all light, soft work being run first and the harder elasses at the end of the heat.

On aceount of the lack of elasticity and its massiveness, cast iron is ideal for frames for machinery of all kinds, and as it ean be locally ehilled to give splendid wearing surfaces where needed, built-up structures of several materials can be avoided. The roduction in the total carbon through steel additions to the mixture ean be carried to a point when tho ehips taken from such a casting eurl up almost as well as thoso from hard steel, and hence such metal serves very well where it is not essential that steel be used.

Recent Tendencies in Grey-Iron Foundry Practice.

A few words on the more recent tendencies in the production of grey-iron castings will not be amiss. The passing of the war has given us time to realise more fully the train of evils that have been its legacy to the foundry. A cataclysm such as this cannot but have disorganised everything it has touched, and so the foundry is manned to-day by operatives giving but part of the output of previous days, the character of the work is itself poorer, corrective measures are impossible of application, and hence the industry is far behind the present demand for castings. Until labour seeks work, conditions will be no better, and prices are the rule which take into account all kinds of eventualities. So much for the operating end. On the technical side matters are just as bad. While there was a tremendous expansion of other industries due to war demands, the foundries simply pushed production to the utmost consistent with ability to get raw materials and men. Impossible prices for pig-iron resulted in the use of so high a proportion of scrap in the mixtures that when the castings made during this period of stress eventually land into the scrap piles of the country —probably within the next twenty years—a serious problem of very high-sulphur and oxidised iron will confront the foundryman. Instances of 90 per cent. scrap in the mixture were common and castings with over 0.20 per cent. sulphur equally so.

The problem will have to be faced, and there are two possible solutions. The method heretofore employed in such a case is the increased use of pig-iron in the mixtures. Before the war the common practice was to use not over 40 per cent. scrap with 60 per cent. pig. Now it is reversed. Consequently, instead of having the sulphur run about 0.08 per cent. maximum in important work, it is more nearly 0.12 per cent. Ordinary work to-day touches 0.18 per cent. without much comment. It is true that even a higher sulphur content will not militate against machinability provided the melting practice is of the very best, but the castings are more subject to danger from shock and casting strains.

The other method for correcting the high-sulphur tendency in daily work at present and for that to come would be a desulphurisation process. Until very recently no method of this kind was available, but fortunately the electric furnace has been drawn upon for this purpose and is doing the work with complete satisfaction. Instead of melting the charges from the cold state, as is the case in electric-steel developments, the regular cupola method is employed and the molten metal is transferred into an electric furnace having a basic lining. In this way the heavy current variations are avoided and by taking advantage of the comparatively cheap cupola-melting cost, that of the electric furnace for refining only is very materially reduced. It is a question whether more than an eighth of a penny is thus added to the cupola melting cost per pound of metal "duplexed," where current is cheap.

Molten cupola metal with possibly 0.12 per cent. sulphur may thus be brought down to about 0.05 per cent. and even lower. Moreover, the metal is highly superheated—cupola metal itself is intensely hot as compared with furnace iron—and thoroughly deoxidised. The castings made are therefore much better and sounder than the ordinary run, equalling charcoal-iron castings made in the air furnace. The first cost of the installation is high, but soon pays for itself in the quality of work turned out. While developed during the war period it is none the less a logical sequence in the world advance of the art of making iron castings, and should be welcomed as a satisfactory way out of a very bad situation ahead.

In conclusion, the mechanical engineer is urged to turn his attention more specifically to foundry operation. The technical staffs of all the foundries of Continental Europe, from manager down to assistants in the several production and testing departments, are all graduate engineers. The consequence is that castings are made strictly for the purpose intended and not merely to get by the machine shop safely, as is unfortunately so often the case here. Close co-operation between men trained in the science with those trained in the art of making castings can result only in good.

Porosity and Surface Defects of Malleable Cast Iron.*

By Marcel Remy, of Herstal, Belgium.

It is common knowledge that, under certain conditions, all cast metals will show scabs, pulls, or blowholes. This matter becomes particularly serious when the piece has to be machined and completely finished before being subjected to pressure. Various remedies have been suggested, and, in America, attention has been paid to the moulding process rather than to any modification of the metal; to this end large risers and feeders have been successfully employed.

In attempting to discover the cause of these blowholes or "honeycomb," it has been noticed that they occur more frequently in certain parts of the mould, at the junction of two arms, for instance. This may be due to the entrapped gas from the mould penetrating the metal before it sets. Another suggestion is that the water of combination in the clay—released at about 500 deg. C.—may produce the honeycomb effect by its instantaneous vaporisation. Mons. Kluytmans attributes the effect to segregation of pearlite at the junction of sections, such segregation being influenced by the direction of the stream of metal when teeming. Prof. Touceda remarks that the casting temperature is indicated by the appearance of these defects. If black, a very hot cast has been made; a dark grey suggests hot metal, and a light grey a cold cast.

In considering these defects of malleable castings, a great many contradictory features are presented, and it is essential that a long and systematic inquiry should be undertaken and that all foundries should contribute their experiences.

Influence of Silicon and Manganese on the Tensile Strength of Malleable Cast-Iron.

Certain abnormal results have been obtained during tensile tests of "black heart" malleable castings, 31.6 tons per sq. in., with an elongation of 25 per cent. is a figure that surpasses the tests of the best irons known. It is the opinion of Schwartz, however, that the accepted tensile values for pure iron are out of date, and that they should be revised with the aid of modern apparatus and methods. Schwartz suggests that manganese may have a marked effect in this matter of tensile strength and that a great deal of research remains to be done from the point of view of the sequence of solidification of the various components of malleable iron during cooling. An American authority declares that the effect is due to silicon, which may be in solid solution with the ferrite—giving a silico-ferrite matrix—which, alone, would be tenacious and ductile and, at the same time, be easily machinable. To this end he recommends a silicon content of 1 per cent. when possible. This question presents an extremely interesting and valuable subject for research..

Modulus of Elasticity of Malleable Cast-Iron.

According to M. de Fleury, in *Revue de Métallurgie*, May, 1922, the modulus of elasticity of malleable cast-iron is little more than half that of steel. In the same issue M. Portevin remarks that this value is probably the same as that of semi-steel. Mr. Schwartz, who has made an exhaustive study of the material, describes an experiment which gave 22,500 as the modulus, but considers this figure too high in view of results obtained during tensile and compression tests. He suggests a maximum of 20,300 and a minimum of 17,500 for this value.

Advantages of Malleable Cast-Iron.

Resistance to vibration and repeated shocks is an important feature of malleable cast-iron, and this property should be considered in comparison with other metals, especially steel. For equal strength malleable is much easier to machine than is steel, because the graphitic carbon acts as a lubricant to the tool.

The late Mr. C. B. Brooks, metal merchant, of 13, Leadenhall Street, E.C., left £168,810.

* Abstract of a Paper presented to the Nancy meeting of the Association Technique de Fonderie.

Trade Talk.

Needham Bros. & Brown, Limited, are making extensions to their Borough Foundry, Pontefract Road, Barnsley.

Pease & Partners, Limited, propose re-opening their Lingdale Mines, Skelton, at the commencement of next month.

The Late Mr. R. W. Young, of Middlestown, near Wakefield, a director of William Jarvis & Sons, Limited, ironfounders, left £4,443.

Considerable damage was done by a fire which broke out in the engine-house at the foundry of the Callendar Iron Company, Falkirk.

Mr. J. Brunton, of 28-30, Lime Street, London, E.C.3, has been appointed agent for Universal Bolts & Nuts, Limited, of Old Hill, Birmingham.

Hobdell, Way & Company, Limited, engineers, merchants, etc., have removed from St. John's House to 45, Church Street, Minories, London, E.1.

Orders have been received at the Crewe Railway Works for 30 locomotives for the London and North-Western Railway. A large order for new boilers has also been received.

R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, and M. Arnott & Company, Coatbridge Boiler Works, Coatbridge, have joined the Federation of British Industries.

Mr. Harold E. Yarrow, president of the Institution of Engineers and Shipbuilders in Scotland, delivered his presidential address to a meeting of the members held last week.

The Tool Trades Technical Society commenced their session on Thursday last with a discussion on the duties and efficiency of tools and saws from the machinery users' point of view.

W. R. Baxter, Limited, successors to the Mechanical Packing & Accessories Company, have removed their registered office and warehouse from Windsor Place, Cardiff, to 30, Crwys Road, Cardiff.

In consequence of the reconstruction of a portion of the works, several hundred men employed at the steel works of Alfred Hickman, Limited, Spring Vale, Bilston, have received notice to cease work in a week's time.

Mr. L. F. Richardson, formerly a director of White Bros.' Engineering and Machinery Company, Limited, has established himself in business as an iron, metal and machinery merchant at 30, Trinity Square, London, E.C.

The dulness of the iron trade together with the recent rise in the price of coke has necessitated the blowing out of one of the blast furnaces of Alfred Hickman, Limited, Bilston, Staffs., and a second one at one of the associated firms.

On Thursday last the members of the Chemical Society met at the Institution of Mechanical Engineers, when Sir William H. Bragg, in conjunction with Professor W. L. Bragg, delivered a lecture on "The Significance of Crystal Structure."

Mr. Conrad F. Mendham, consulting engineer, of 77, Belgrave Road, S.W.1, is closing down his practice in London to take up a position in Hong Kong as assistant managing director for W. S. Bailey & Company, Limited, engineers and shipbuilders.

Mr. Ernest Doxford, a past-president, has given £500 to the endowment fund of the North-East Coast Institution of Engineers and Shipbuilders, and the Furness Shipbuilding Company have given £500 towards the maintenance of the Middlesbrough branch of the Institution.

The auditor's report on the average selling price of South Wales tinplate bars states that for July, August and September it was £7 2s. 0½d. The recent agreement does not affect the scale percentages under the sliding scale, but the question of a continuation of *ex gratia* bonuses will probably be a matter for consideration.

At a meeting of the Grand Council of the Federation of British Industries Sir Eric Geddes was nominated for the position of president during the coming year. The following additions to the list of vice-presidents were also recommended: Mr. Arthur Balfour, Sheffield, steel; Lord Colwyn, Manchester, rubber; Colonel R. K. Morcom, Birmingham, electrical engineering; Sir Henry White Smith, Bristol, aircraft; and Sir George Sutton, Bart., London, cable makers.

Recently Mr. J. S. Taylor (Taylor & Challen, Limited, Birmingham) attended a meeting of the Birmingham Chamber of Commerce for the purpose of handing to the president, Mr. F. Hickinbotham, a presidential chain and badge of office for use on official and ceremonial occasions. Mr. Taylor, who is now in failing health, was president of the Chamber for the six years ending March, 1910. On learning that the Lord Mayor of the City had suggested the provision of a presidential chain of office, Mr. Taylor asked to be allowed to provide the decoration.

Gazette.

Trading in the style of Dieny & Lucas, Messrs. P. Dieny and C. Lucas, 329, High Holborn, W.C., engineers, have dissolved partnership. Debts by Mr. C. Lucas.

Trading in the style of Alwyn & Martin, Messrs. H. Alwyn and J. N. Martin, 46, Bloomsbury Street, London, engineers, have dissolved partnership. Debts by Mr. H. Alwyn, who continues business in his own name.

Trading under the style of Block, Deroy & Company, Messrs. E. V. and R. Block, Carlton House, Regent Street, London, S.W., metal merchants, have been adjudicated bankrupts. Examination, Bankruptcy Court, January 17.

Bankruptcy proceedings have been instituted in the case of Mr. F. J. Ratcliffe, trading as Ratcliffe & Sons, the Boiler House, Hawarden, iron, steel and machinery merchant. Examination, The Castle, Chester, November 21, at 11.

Trading in the style of the Oxy-Acetylene Welding and Engineering Company, Messrs. W. Jordan and J. Charlesworth, 3, Deacon Street, Leicester, oxy-acetylene welders and general engineers, have dissolved partnership. Debts by Mr. J. Charlesworth.

Stelabrass, Limited.—It has been resolved that the company be wound up voluntarily. Mr. J. R. Kinnis, Union Bank Chambers, Riby Square, Grimsby, C.A., has been appointed liquidator, and Mr. W. R. Boyd, 67, Cleethorpe Road, Grimsby, C.A., receiver.

Adjudication annulled and receiving order discharged.—Mr. W. Haynes, 69, Southwark Street, Borough, and 21, Denning Road, Hampstead, metal merchant. August 9, the Court being satisfied that a scheme was duly approved by the creditors, and that the terms thereof were reasonable and calculated to benefit the general body of creditors, and that the case was one in which the Court would not be required to refuse an order of discharge.

Manufacturers' and Merchants' Quotations.

Extruded Brass Rods.—McKechnie Bros., Limited, Rotten Park Street, Birmingham, quote extruded brass high-speed turning and screwing rods at 6¼d. per lb. basis.

Gunmetal and Phosphor Bronze Tubes, Rods, etc.—Charles Clifford & Son, Limited, Fazeley Street Mills, Birmingham, quote for rods, ¼-in. to 1⅝-in. dia., 1s. 2d. per lb. basis; gunmetal tubes (drawn), 1s. 5½d. per lb. basis; phosphor bronze chill-cast bars, 1s. 1d. per lb. basis.

Rudge Littley, Limited, Swan Village, West Bromwich, offer phosphor bronze chilled sticks at 1s. 3d. per lb.; ditto, chilled tubes, 1s. 4d. per lb.

Hexagon Steel Bars.—Pearson & Knowles Coal and Iron Company, Limited, of Warrington, quote soft steel hot-rolled hexagon bars, ½ in. to 2½ in. across flats, at £11 10s. per ton, net cash, f.o.t. works.

Scrap Metals.—A. Joseph, Earl Street, London Road, S.E.1, quotes buyers' prices for non-ferrous scrap metals as under:—New aluminium cuttings, £60; general collected scrap brass, £32; clean copper, £56; braziery copper, £46; gunmetal, £40; old lead, less usual draft, £21 10s. (all metal carted free in London area); tea lead, £19; old zinc, £23; hollow pewter, £125; shaped black pewter, £80.

Williams & Foulds, Britannia Works, Watery Lane, Birmingham, quote:—Clean brass swarf, £30; clean gunmetal swarf, £35; gunmetal scrap, £40; clean heavy brass scrap, £32; new brass sheet cuttings, £40; clean heavy copper scrap, £54; clean braziery copper scrap, £49; new aluminium sheet cuttings, £60; clean aluminium cast scrap, £50; clean aluminium swarf, £30; scrap zinc, £17; scrap lead (less usual draft), £21.

Contracts Open.

Toronto.—Supply of blue annealed steel sheets 34in. by 71 by 15 b.w.g. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Cardiff.—For supplying and fixing approximately 1,436 yards of six-wire reinforced concrete post and wire fencing at Craigwen, Penyrheol and Caerphilly, for the Glamorgan Agricultural Committee. The County Land Agent, 30, Park Place, Cardiff.

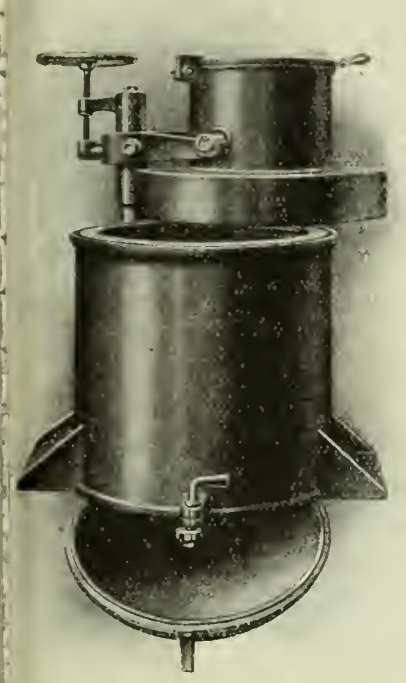
London, S.W., November 3.—Supply of (1) mild-steel bars, sections, etc.; (2) Yorkshire iron; (3) wrought iron; (4) spring steel; (5) bolts, nuts and rivets, etc.; for the South Indian Railway Company, 91, Petty France, Westminster, S.W.1. (Fee, 10s., non-returnable.)

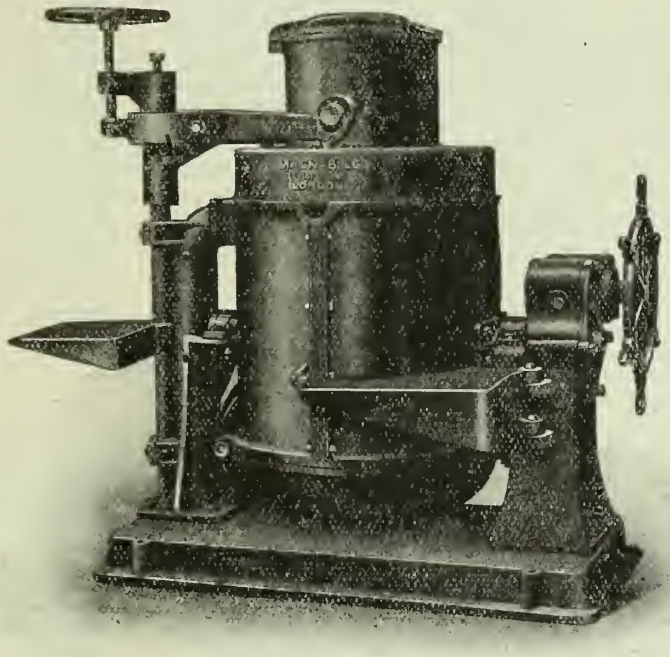
MACNAB & CO.

METAL MELTING CRUCIBLE FURNACE

For Brass, Gunmetal, Aluminium, Iron, etc.

Reduce your fuel cost! **Melt in a hurry!**





ylor Patent Pit-Type Furnace.

UTPUT.
200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.=1093° C.

CONOMY.
25 lbs. of Coke used per 200 lbs. of Metal melted.

TANDARD CRUCIBLES.
Lasting 35 to 40 heats.

Tylor Patent Tilting-Type Furnace.

OUTPUT.
450 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
80 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 30 to 40 heats.

6/8, EAGLE STREET, SOUTHAMPTON ROW, LONDON, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

IRON AND STEEL MARKETS.

Pig-iron.

Compared with the activity evidenced a few weeks ago, conditions in the pig-iron trade have assumed a much quieter aspect, consequent upon a very diminished demand for American shipments. The general state of the industry may, however, be more accurately estimated by a glance at the September returns of blast furnaces in operation at the end of that quarter. This shows that the total number of furnaces built on that date was 487, of which 138 were in blast, showing an increase of 21 since the end of the June quarter. It is some satisfaction to learn that the outputs, though on a restricted scale, are being absorbed, very little iron remaining in makers' stocks, due in a great measure, of course, to the recent heavy exports to the United States, now unfortunately in much diminished quantities. In the South Staffordshire area inquiries suggest some revival in the foundry trade, and smelters are hopeful of improved business in the better qualities of pig. Recently the trade in these has been rather disappointing, and manufacturers have severely felt the want of support which formerly they derived from it. The demand for forge iron remains quiet, and there is nothing encouraging in connection with it. Smelters are adversely affected by the advance in fuel costs, because they are unable to recoup themselves in the prices charged to consumers. At present the market will not stand any higher price for pig-iron, which has remained firm all through the summer, while the prices of other iron and steel products have considerably decreased. Scottish pig-iron smelters are still kept busy on export trade completing contracts on American account, over 7,500 tons having been shipped to Atlantic ports a week ago, a record quantity in that period for a long time past. On Clydeside generally, however, there is no improvement to report in the demand for pig, and as far as the engineering founders are concerned business has never been worse. Until the shipbuilding trade picks up, no improvement can be expected, and whilst some more orders have been placed on the Clyde, the improvement is inappreciable. Business on Tees-side during the past week has been in disappointing volume, the demand from America having fallen away, and for the moment buyers on the other side are holding off, and watching developments in their own market. On previous occasions American requirements have usually been satisfied within a period of about three months, but conditions at the present time are so abnormal that it would not be surprising if another spurt in demand were experienced. Meantime, however. the Cleveland makers have still considerable quantities to clear off their books, and are not likely to be worrying for some weeks to come.

The steady revival of demand for steel products has induced a corresponding recovery in the hematite industry, makers' stocks having practically disappeared, and outputs at furnaces in blast making this particular quality of iron being fairly absorbed in supplying consumers' requirements. At Middlesbrough there is a fair volume of inquiry still coming forward, though it is not at the moment eventuating in much business. The improvement in the home demand is, however, maintained, and the comparative scarcity of scrap would seem to point to an increasing consumption of hematite. Altogether, with fuel costs so high, there is no weakness on the part of producers, and 92s. 6d. appears to be a minimum figure for East Coast mixed numbers, with a premium of 6d. to 1s. per ton for the No. 1 quality. Similar conditions to those above outlined are experienced in Cumberland, and here, again, prices are firm and unchanged at 105s. delivered Sheffield or Clyde port.

Finished Iron.

Business in the various sections of the finished iron trade continues disappointing, and with the one exception of marked bars remains in its previous stagnant position. Manufacturing interests in South Staffordshire are especially affected in this direction, consumers continuing to hold off markets and buying only for immediate requirements, with the result that forward business is at a standstill and only about 50 per cent. of the productive capacity of the district is employed. Some explanation of the conditions now ruling in the industry may be supplied hy the excessive competition experienced not only from foreign makers, but also between home producers, who, in their anxiety to keep mills running, will often accept orders at unremunerative prices to secure current business. Among the materials most subject to competition in this connection may be instanced nut and holt iron, which has recently been bought fairly freely at £9 15s. In this material there is also Belgian competition at about £8 10s. delivered, and it is noteworthy that Midland makers are able to make any sales against such a price. A fair quantity of iron gas strip is reported to have been sold at £10 10s., although the local quotation is 5s. higher. The result is an impending reduction in the output. The demand for good crown iron is very spasmodic, but on the whole the price of this quality keeps fairly steady owing largely to the relatively high cost of production. Costs are so heavy that some makers let business go past them rather than cut their price to obtain it. Foundrymen still find just cause for complaint in depleted order books.

Scrap.

Although generally quiet on the whole, a certain degree of activity may be noted in a fairly brisk market for steel scrap, about the only section of the trade now evidencing much vitality. The demand for this class of material is fairly general all round, but the output of heavy steel scrap is at present only on a limited scale, and supplies are inadequate to smelters' requirements. This may probably be explained by the recent heavy shipments of this quality scrap to Germany, while consumers in South Wales have also bought freely until quite recently. Some disparity in the prices for heavy steel scrap is also observable, for while South Wales is reported to have paid up to 72s. 6d., this particular quality is quoted at 65s. to 67s. 6d. per ton. Taking Middlesbrough as a representative market, there is now a fair demand for certain classes of scrap, principally heavy steel scrap, steel turnings, and cast-iron borings. Heavy steel can be disposed of readily at 68s. to 68s. 6d. per ton, delivered works. For heavy short steel turnings quotations rule 54s. per ton, and cast-iron borings realise approximately 52s. 6d. Although there is no great demand for heavy cast-iron machinery scrap in handy pieces the position is somewhat better and the price ranges from 75s. to 77s. 6d. per ton. There is still practically no demand for heavy wrought-iron scrap, and the prices are purely nominal at 55s. to 57s. 6d. for bushelling, 60s. for ordinary heavy piling, and 70s. to 75s. for specially selected heavy forge. All quotations are delivered.

Steel.

General gratification is expressed in steel trade circles that the Admiralty authorities have decided to invite tenders for the construction of the new battleships which it is hoped will give a much-needed stimulus to business in the chief centres of industry, both as regards semi and finished products employed in warship building. In this connection it is much to be hoped that the Government will divide the contracts as much as possible in the various districts, in order to relieve the unemployment now experienced in most steel-making centres.

Metals.

Copper.—Although a fairly active business has been passing in the standard copper market buying movements continue confined within narrow limits, and are chiefly restricted to the speculative section on 'Change. Current quotations :—*Cash* : Wednesday, £62 17s. 6d.; Thursday, £62 15s.; Friday, £62 12s. 6d.; Monday, £63 2s. 6d.; Tuesday, £63. *Three months*: Wednesday, £63 10s.; Thursday, £63 7s. 6d.; Friday, £63 7s. 6d.; Monday, £63 15s.; Tuesday, £63 12s. 6d.

Tin.—Under exceptionally favourable statistical conditions the market for standard tin has recently developed remarkable strength, and with movements indicating a further advance in values sellers are showing some reserve, especially in the East. Current quotations :—*Cash* : Wednesday, £176 15s.; Thursday, £177 7s. 6d.; Friday, £180 10s.; Monday, £184 10s.; Tuesday, £184. *Three months* : Wednesday, £177 10s.; Thursday, £178 2s. 6d.; Friday, £181 5s.; Monday, £185; Tuesday, £184 10s.

Spelter.—Values of this metal have experienced a further sharp advance, and market conditions continue very firm. Current quotations:—*Ordinary*: Wednesday, £36 10s.; Thursday, £37 10s.; Friday, £37; Monday, £37; Tuesday, £37 10s.

Lead.—The demand for soft foreign pig is fairly well maintained, but prices have reacted in an irregular market. Business, however, has been fairly good and the condition of the market looks sound and healthy enough, but the market has been affected by fairly heavy arrivals of Mexican lead, which occasioned no little surprise. Current quotations:—*Soft foreign (prompt)* : Wednesday, £27; Thursday, £27; Friday, £26 5s.; Monday, £26 10s.; Tuesday, £27.

THE

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Contents.

	PAGE
Foundry Prejudice	373
Correspondence	374
Cast-Iron or Steel Water Pipes	374
Deaths	374
The "Hestia" Core Stove	375
Notes from the Branches	375
High Tenacity Brasses	376
American Fonndrymen's Association	376
A Visit to the Works of Messrs. Fraser & Chalmers	377
A German Steel-Maker on the Situation	682
Estimation of Minute Percentages of Iron in Foundry Materials	383
Contracts Open	383
Reverberatory Furnace for Non-Ferrous Metals	384
Some Notes on the Production of Sound Castings	385
Dolomite for Refractories	385
Institution of British Foundrymen	386
Iron in Copper and its Alloys	388
Book Reviews	388
An Apprenticeship Course in Foundry Practice.—XVII.	389
Inventions	392
Trade Talk	393
Company News	393
Gazette	393
Iron and Steel Markets	394

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

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Foundry Prejudice.

For the purpose of this article we take prejudice to mean an opinion or decision of the mind formed beforehand and more or less unwarranted or unreasonable.

From whatever angle foundry work is viewed, prejudice looms large. Primarily, it is commonly supposed that there is a general prejudice by the engineering industry at large against entering the foundry because of the very bad conditions which are still found here and there. However, it is not this external phase with which we propose to deal, but rather an internal aspect which operates against innovations.

It may sound curious to many of our readers, but there exists here and there militant prejudice against the Institution of British Foundrymen, which, being a prejudice, has no sound base, but, according to one foreman moulder whom we recently interviewed, his objection was that it cultivated, *without protest*, the general principles of metallurgy, and this *after three or four decades of liberal education*. Such an attitude is difficult to comprehend, and enlightened foundrymen would do well to ascertain to what extent this attitude exists. We suggest that it is useless for a member who is known to be an enthusiastic supporter to do any direct questioning, as he would receive nothing definite from prejudiced persons, but rather to question a less enthusiastic member about his foundry associates. The enthusiast would be accused of being prejudiced. As the Institution has less than one representative from each iron foundry, it is interesting to ask why. We can only assume that there are two answers; one is the impossibility of a local branch, and the other prejudice. Perhaps, as we have previously suggested, the holding of two annual meetings, as do *all* similar societies, would do much to remove the first cause.

A second phase of foundry prejudice is against innovations. If exhibited by the managers or foremen, we are of opinion that the provision of adequate experimental funds, so that the new material or machine cannot operate against departmental profits, would dissipate prejudice. The previously-mentioned foreman put forward as his studied opinion that he would not give foundry floor space for a certain type of moulding machine. This is a standard machine of international reputation, which, to our own personal knowledge, is doing excellent work in a large number of foundries.

There exists amongst some foundrymen a prejudice, both personal and professional, against the foundry analyst or metallurgist. If prejudice is made personal, it is usually heard of through a third person. This, too, can usually be dissipated by insisting, wherever possible, on an immediate triangular conference between the originator of the prejudice, the gossip-monger, and the injured person. Such a conference, though unpleasant at the opening, will do more to bring about close co-operation than any nursing of grievances preparatory to different action.

Whilst, psychologically, remedies can be found in some cases to overcome prejudice, it would be interesting to appreciate its origin. We imagine it to have its birth in the non-realisation that there are many types of brains, using the word in its "right of common usage" sense. In the foundry, prejudice has arisen occasionally because a practical foundryman imagines that, because the metallurgist does not immediately grasp the moulder's idea of the best method of making a job, that he is devoid of common sense, and the chemist receives similar ideas when the moulder fails to appreciate the influence of the simple elements on cast-iron. It thus becomes apparent that it is this inability to appreciate each other's brains and outlook that causes prejudice. If the two could only co-operate for a time sufficiently long to assimilate mutually each other's life-work, they would each receive the necessary insight into the other's craft, that would make them realise their true inter-dependence.

The foundry trade undoubtedly is very much tainted throughout by silly prejudices, and any effort that can be made to drive them away should be welcomed. A general survey emphasises that "what is one man's meat is another man's poison," and an effort should be made by people having prejudices to procure for themselves an antidote so that, whatever meat is available, they can easily digest it.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Capital Required for New Steel Foundry.

To the Editor of The Foundry Trade Journal.

Sir,—Would any reader give me a rough estimate as to the capital required to start up a steel foundry capable of turning out 10 tons of castings per week, the weight of castings being from a few pounds to 6 cwts., together with the approximate space required for both foundry and dressing shop?—Yours, etc.,

S. J. B.

Steel Foundry Facing Sand.

To the Editor of The Foundry Trade Journal.

Sir,—Would any reader please advise me as to the best methods of grinding a steel foundry facing sand? The sand in use consists of 20 per cent. siliceous clay and 80 per cent. silica sand. The clay in question, when received, contains a great amount of moisture, thus making it very plastic; also the silica sand is received in a very wet condition. The sand-grinding mill the writer is using is a revolving pan type, fitted with two flat rollers. The writer has in mind that the mill in question is not of a suitable type, and it would be more satisfactory if a mill was used that acted more in the way of a mixer, as the clay is not distributed equally with the silica sand, but is rolled into cakes and the grain of the silica sand crushed. Any information that will help the writer to overcome difficulties mentioned will be very much appreciated.—Yours, etc.,

Steel Foundryman.

Locomotive Cylinders.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with much interest Mr. A. F. Gibbs' Paper on "Locomotive Cylinders," and hope we shall have more practical Papers like this which show plainly how castings are produced in the different foundries and of use to the practical foundryman.

There are a few points on which I should like the author to give some further information.

From the analysis given of the iron used, it would seem to be of too open a character for use in such heavy cylinders as those dealt with, and not likely to give any good results under water test, which is an important feature in this class of casting. From experience, the silicon would be better if from 1.0 to 1.4 per cent., with a higher manganese and lower phosphorus content, to be satisfactory. There may be some method in casting that makes the castings give such good results which the author does not give.

Another feature is the weight given for the charge used in a cupola of five tons per hour melting capacity. Does not 8 cwt. seem small? Should not this be nearer 20 cwt., to be economical and efficient? Also how are the four Roots blowers used for melting; this seems a new departure?

The methods of moulding are no doubt expensive, but this seems to be amply repaid by the results shown in the extremely low percentage of waster castings. This would seem that they must have also a sane method of inspection at the G.E.R., which does not scrap castings for trivial defects. The drawing office can put $\frac{1}{2}$ in. dia. holes anywhere in the barrel of a cylinder for lubrication, but the foundry must not produce castings with only one $\frac{1}{8}$ in. dia. hole to scrap them in some shops.—Yours, etc.,

Foundryman.

October 29, 1922.

Gothenburg Exhibition.—An Exhibition, celebrating the 300th anniversary of the city, which is the chief seaport of Sweden, will be held from May 8 to September 30, 1923, at Gothenburg. There will be exhibits from every branch of Swedish industry, and especially those industries for which Sweden has established a reputation.

Cast-Iron or Steel Water Pipes.

Newport Corporation are considering the question of the pipe line in the Talybont water scheme. Messrs. D. M. Hill & Sons, their engineers, strongly urge the use of cast-iron pipes, as the life of a steel pipe buried in the ground and conveying water is subject to corrosion both externally and internally. Experienced engineers would not use steel pipes if the conditions are such as to permit the laying of cast iron. When they turned from steel pipes to iron pipes they passed from doubtful speculation to proved experience.

In Manchester there were several mains up to 40 in. in diameter which were laid in the year 1850, and were as enduring to-day as then. There were mains in London which were laid in 1811, and examined in 1915, and were found to be both internally and externally as good as the day they were laid. In fact, no limit could be said to the life of a cast-iron pipe.

A proposal will be made to the Council that the contract for laying the cast-iron pipes for the scheme be placed with Messrs. Cochrane & Company, Limited, of Middlesbrough, at a price of £101,906 11s. 2d., and that the proposal to sub-let a part of the contract for cast-iron pipes to Messrs. Jordans, Limited, and Messrs. Thomas Spittle, Limited, Newport, be revoked.

The members of the Corporation visited the Mannesmann Tube Works, and saw the 54-in. steel pipe of the Manchester Waterworks being made.

A letter was read from Mr. T. Trevor Williams, engineer to the Swansea Council, stating that steel tubes were far less liable to corrosion than cast iron. He strongly recommended steel tubes for water mains.

Deaths.

Mr. P. Ellison, formerly an ironfounder at Silsden, Yorks, has died at the age of 66 years.

Signor Ernesto Stassano, the Italian inventor of the steel-making electric furnace known by his name, died recently.

Mr. W. Campbell, Hebburn-on-Tyne, Inspector of Forgings in the Newcastle District for Lloyd's Register, died last week aged 65 years.

Mr. O. Bagshaw, director of William Green & Company, stove manufacturers, of Ecclesfield, and manager of a branch of that firm at West Bar, Sheffield, died recently.

Mr. H. Denton, of The Poplars, Oakland Road, Hillsborough, died last week. He was well known in the steel trade, being partner in the firm of Denton & Best, Birley Meadow Steelworks, Owlerton, Sheffield.

Sir Prince Smith, Bart., of Prince Smith & Son, textile engineers, Keighley, died at Driffield on October 20, in his 82nd year. The deceased Baronet is succeeded in the title by his son, Mr. (now Sir) Prince Prince-Smith, of Whinburn, Keighley, who has been closely associated with his father in the business for many years.

Mr. W. H. Scott, of Moorside, Fenham, one of the principals of the firm of Scott & Turner, Limited, Gallowgate, Newcastle, died suddenly last week. In addition, he held the position of chairman of the Tyne Metal Company, Limited, and was a director of Raine & Company, Limited, iron and steel manufacturers. Mr. Scott was in his 63rd year.

Mr. W. Benson, a founder of the firm of Adams & Benson, Limited, iron and steel merchants, of West Bromwich, died on October 20, at 71, Exeter Road, Exmouth, in his 73rd year. The deceased gentleman, who has been connected with many Midland iron and steel firms, latterly established himself in a smaller business as an iron merchant at Exmouth.

Terni Steel Works.—This Italian concern is to amalgamate with the Società Italiana per il Carburo di Calcio. An exchange of shares is to take place at the rate of four Terni shares for three Carburos.

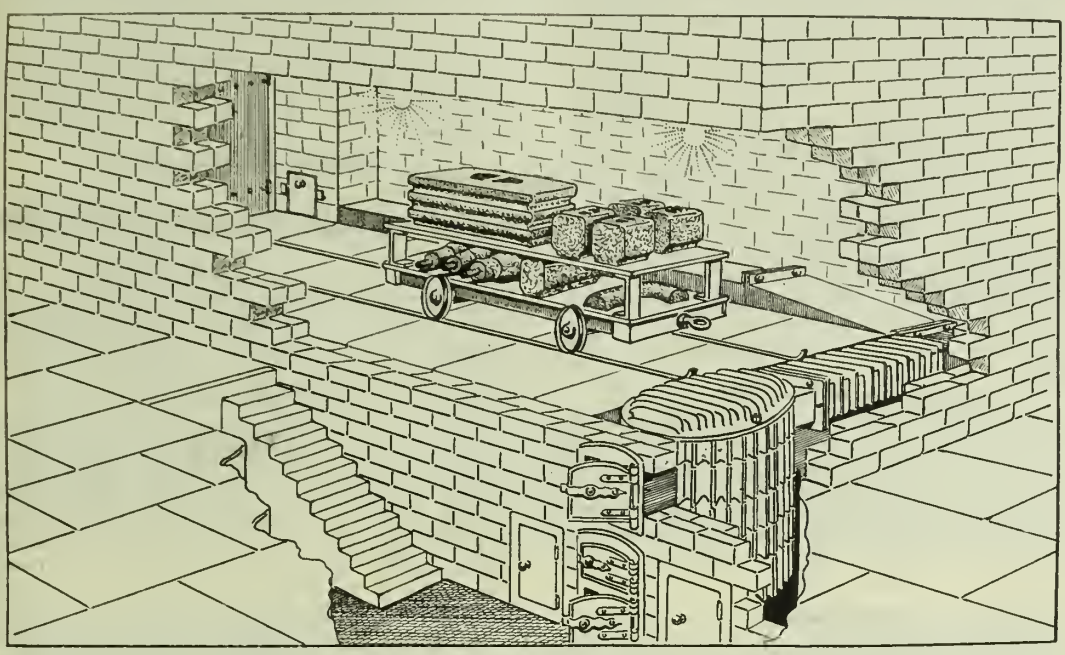
Mr. J. Cook, for fifty years machine shop superintendent to John I. Thornycroft & Company, Limited, has been the recipient of a presentation from Sir John Thornycroft, at the Woolston Works, on the occasion of his retirement. Mr. Cook will retain his connection with the firm in a consultative capacity. He has been a member of the London Association of Foremen Engineers since 1888, and was president in 1895.

The "Hestia" Core Stove.

By J. M. Lockhart.

Genuine and successful attempts to improve the atmospheric conditions prevailing in most foundries are so rare that an account of a new core and mould-drying stove which has been constructed and provisionally protected by Messrs. John Grundy, Limited, the well-known heating and ventilating engineers, of Tyldesley and London, will be of interest to all foundrymen.

The immediate object of the designers was to make the interior of the core stove fit for human beings to enter, and at the same time to do away with the large volumes of black, sulphurous, smoke and soot which pour into the foundry each time the stove doors are opened. They have not only succeeded in doing this, but have obtained an efficiency in action and an economy in both fuel and labour far beyond their expectations.



The "Hestia" Core Stove.

The stove experimented with was of the ordinary type, with a large open coke fire at one end, and was 32 ft. long × 10 ft. wide × 7 ft. high, with accommodation for two large core wagons. In place of the open-fire Messrs. Grundy have substituted one of their special slow-combustion air-heating furnaces, in which a large volume of air is passed, entirely without the aid of fan or motor, over the gilled surfaces of the firebox, and does not come into contact in any way with the products of combustiou, the air thus retaining all its original oxygen, and therefore its drying qualities. This large quantity of air is circulated throughout the core stove at a temperature of about 205 deg. C. (400 deg. Fah.), and very quickly and thoroughly extracts the moisture from the cores, moulds, etc., and, as the temperature is the same in all parts, it does not in any way distort, crack, or swell the cores.

By this method the cores are uniformly dried throughout their bulk, not simply skin-dried or burnt on the surface only, as is so often the case in cores baked in open fire stoves, and as a consequence they give out a minimum of gas during the process of casting.

The furnace has been placed towards the back end of the stove and below the level of the floor, leaving the whole of the interior available for drying purposes. This position has also the advantage of making stoking into a very easy operation, the coke being simply shovelled down a chute placed on a level with the ground close to the outside wall of the stove. The fumes from the burning coke in the firebox are carried along flues running at the bottom of the inside of the stove, from which a considerable amount of supplementary heat is passed into the chamber, and out to the air by way of a chimney, which also takes away the moisture-laden air from the lower part of the stove through a damper, which can be adjusted as required.

There is thus an entire absence of smoke and soot inside the stove, the cores coming out quite clean and free from dust; in fact, the walls are cleanly whitewashed and electric light is installed. When once the fire is well alight the whole charge of coke for 24 hours' working is put on, and little or no further attention is required. In an actual test, starting from cold, only 5 cwt. of coke was consumed in 24 hours' full working, the amount of ash remaining at the end of that time being 51 lbs.

For many years Messrs. John Grundy, Limited, have been making large grinder-body castings up to 34 ft. in length and 16 tons in weight, in which a dozen or more long cores touch end to end. Since installing the new core oven they have only made one of these, and in this case the cores went into their places entirely without rubbing. This has never occurred before, and they attribute the absence of swelling solely to the new method of core drying. The cores also gave off considerably less gas during casting, thus showing that the drying had been efficiently done.

It is interesting to note that almost any large core stove can easily be converted to this system.

Notes from the Branches.

London.

An extra lecture has been arranged for December 7, when Mr. J. Longden, of Messrs. Tullis & Company, of Glasgow, will present a Paper on "Some Casting Problems of Acid-Resisting Irons." The Branch-President, Mr. Wesley Lambert, left yesterday on a business trip to the States. He hopes to be back in time for Mr. Longden's Paper.

Foundry Queries.

High-Pressure Sand Blasting.

Question: Could you give me any information concerning high-pressure sand-blasting, working with pressure of 80 to 100 lbs. per sq. in., particularly with reference to the size of nozzle, the nature of the hose and the abrasive material used, and similar useful information? Are there any such high-pressure plants successfully working in the British Isles?—H. L. S.

Answer.—The question was fully dealt with in a Paper read before the London Branch of the Institution of British Foundrymen by Mr. E. L. Samson. It appeared in the February 16 and 23, 1922, issues of the Journal.—V. C. F.

High-Tenacity Brasses.

Mr. Smalley Replies to Dr. Johnson.

In reply to the points raised by Dr. Johnson in his criticism of my Paper, published in your issue of the 28th ult., I will endeavour to treat these seriatim.

Work of Other Investigators.

May I point out that after completion of my Paper, it was suggested that the Papers for the meeting should not exceed 12 pages. This necessitated reducing my Paper at the last moment to a bare outline of the original, and made it impossible to include comparison data, detailed scientific discussion and to include the development of the more complex series alloys. In fact, on looking over comparison criticisms with the work of other authors and with the mechanical properties of the well-known proprietary brands of high-tenacity brasses, I find this section alone fulfills requirements so far as the permitted dimension of the Paper is concerned. The foundrymen's thanks, however, are due to Guillet, Charpy, Hoyt, Turner, Hudson, Millington, Carpenter and Dr. Johnson himself, whose contributions have done much in bringing this subject to its present state of scientific understanding; and whilst I have not made use of any test results of these investigators in my report, it is only because of publication restrictions.

Direct Application Sought.

In reply to the question raised relative to the mechanical properties and true equilibrium conditions, may I point out that my intention was not to express theoretical equilibrium but practical tests which might have direct application in the workshop.

A Question of Procedure.

In restoring the rolled slabs to the Brinell hardness of the original ingots, the procedure was to anneal small sections at various temperatures to determine the temperature with constant time necessary to reproduce the hardness of the original ingot. This was undertaken because of the reasons pointed out by Dr. Johnson. Each test was made in duplicate at different times.

Zinc Equivalents.

The figures quoted are, as Dr. Johnson points out, fictitious Zn equivalents, and the total value of zinc thus obtained must be recalculated with the actual copper content to give 100 per cent.

Aluminium in High Manganese Alloys.

With reference to overcoming the ready oxidation of the outside skin of high manganese alloys by the aid of small quantities of aluminium, I cannot altogether agree with Dr. Johnson on this point. Small quantities of aluminium are beneficial, and do improve the skin, but it does not altogether eliminate the trouble, and the precautions outlined in the Paper must be observed.

Grain Size Reduction.

This is a problem full of complexities. The theory I offer for the grain-refining effect of small quantities of iron in brass certainly explains observed facts. We do not understand the nature of solution of metals sufficiently well to be dogmatic on the point. It is certain, however, that under 0.30 per cent. iron, when little or none of the iron-rich particles are discernible under the microscope, the grain is reduced but slightly, whilst above 0.30 per cent. when the particles increase in dimension and become visible under the microscope, the grain size is rapidly reduced and appears to reach a limit at approximately 1.0 per cent. of iron. Exceeding 1.0 per cent., the particles tend to aggregate and also to segregate, but the grain size suffers no further change.

The theory offered assumes that iron is insoluble in brass, and that although the iron-rich particles may not be visible under the microscope in brasses containing under 0.30 per cent. of iron, they are merely colloidally or mechanically dissolved. A simple analogy is the suspension of finely-divided particles of graphite in oil or water. The problem of course is much more complicated than this; and as Dr. Johnson states, "the colloidal dispersion theory is not applied easily to metals which appear to go completely into solid solution such as manganese and nickel, and yet which exert a marked reduction on the grain size."

Manganese Compound.

The evidence I offer of the presence of the manganese compound referred to by Dr. Johnson is metallographic. This compound takes a well-defined crystalline form, and is only found in those alloys containing appreciable quantities of both aluminium and manganese.

I can offer Dr. Johnson no quantitative information on the effect of either sulphur or nitrogen on brass. There is no question that under certain conditions, manganese is an effective de-sulphuriser and of value in the recovery of swarf.

Heat Treatment.

The dimensions of the test-pieces used for the tests quoted were 7 in. long 1 in. by 1 in. The comments made on mass effect are the conclusions of a somewhat exhaustive investigation on these alloys in sections ranging from ½ in. sq. to 4 in. sq., quenching one series in oil at 70 deg. Fah. and another in water at 60 deg. Fah. This investigation is somewhat outside the sphere of the foundryman, and will be dealt with elsewhere at a future date.

American Foundrymen's Association.

At a meeting of the board of directors of the American Foundrymen's Association, held in Chicago on October 3, the retiring President, Mr. W. R. Bean, was elected to honorary membership.

The President, Mr. C. R. Messinger, was in the chair, and twelve directors were present.

The board completed its organisation by electing Mr. C. E. Hoyt, Secretary-Treasurer, Mr. R. E. Kennedy, Assistant Secretary, and Messrs. R. A. Bull, S. T. Johnston, L. W. Olson and Fred Erb, who, together with the President, Vice-President and Secretary, will constitute the Executive Committee of the board of directors for the coming year. Mr. C. E. Hoyt was elected manager of the Department of Exhibits.

The directors provided for a permanent Board of Awards, consisting of the seven last living past-Presidents of the American Foundrymen's Association, Inc., with the junior past-President as chairman of the board.

French Invitation Accepted.

An invitation was received from the Association Technique de Fonderie of France, inviting the A.F.A. to join with the foundrymen's associations of France, England and Belgium in an International Convention and Exhibition in Paris the first fortnight in September, 1923. The invitation was accepted and referred to a committee to be appointed by the President, who will represent the A.F.A. and determine to what extent the Association will take active part in the proposed International Convention.

The Committee on International Relations, to whom the Invitation from the French Association for a joint convention was referred, has been appointed by President Messinger, and is as follows:—Messrs. H. Cole Estep (Chairman), S. Griswold Flagg (Vice-Chairman), L. L. Anthes (Toronto), G. H. Clamer, A. O. Backert, and Franklin G. Smith.

Mr. S. Griswold Flagg, of Messrs. Stanley G. Flagg & Company, Philadelphia, Pa., was elected a director to fill the vacancy caused by the death of J. P. Pero. This Mr. Flagg is the son of Mr. Stanley Flagg, junior, who last summer visited England as a delegate from the A.F.A.

Next American Convention.

A report was submitted to the board of directors, recommending that the next Convention be held in the City of Cleveland, and by mail ballot Cleveland was selected, with April 28 as opening day for the exhibits, and April 30 as opening day for the annual Convention, both Convention and exhibits closing on May 3.

A Visit to the Works of Messrs. Fraser & Chalmers.

The invitation of the Directors of Messrs. Fraser and Chalmers, to the London Section of the Institution of British Foundrymen, to visit their works at Erith, Kent, on October 7 was well responded to, there being some fifty members present. The works were not in operation, but the foundry and the whole of the shops were thrown open to the inspection of the members.

The members of the Branch were conducted through the works by Mr. F. W. Lewis (Works Manager), Mr. Whiting, Mr. A. R. Bartlett, and other members of the staff.

It will be recollected that Fraser and Chalmers were taken over by the G.E.C. Limited, in the early part of 1918, and now operate under the title of Fraser and Chalmers Engineering Works (Proprietors, G.E.C. Limited), becoming the mechanical manufacturing works of this large organisation.

The works were originally established in 1890

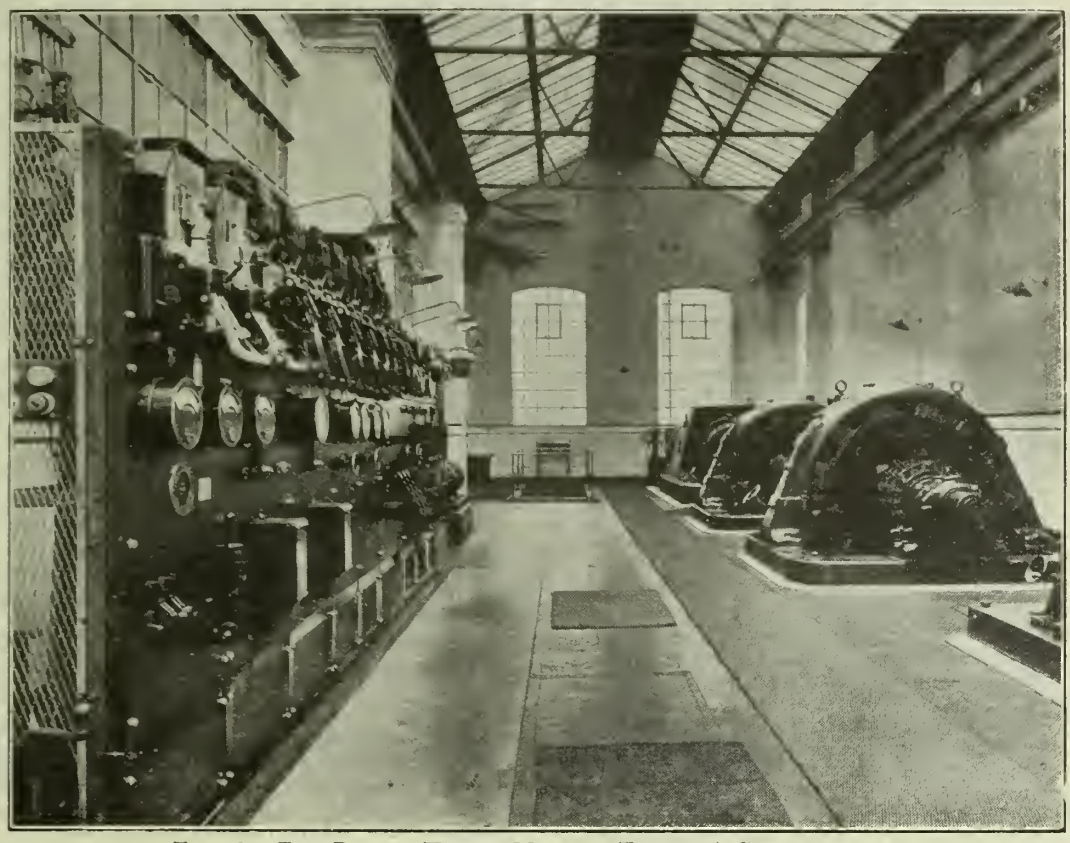


Fig. 1.—The Power House—Messrs. Fraser & Chalmers.

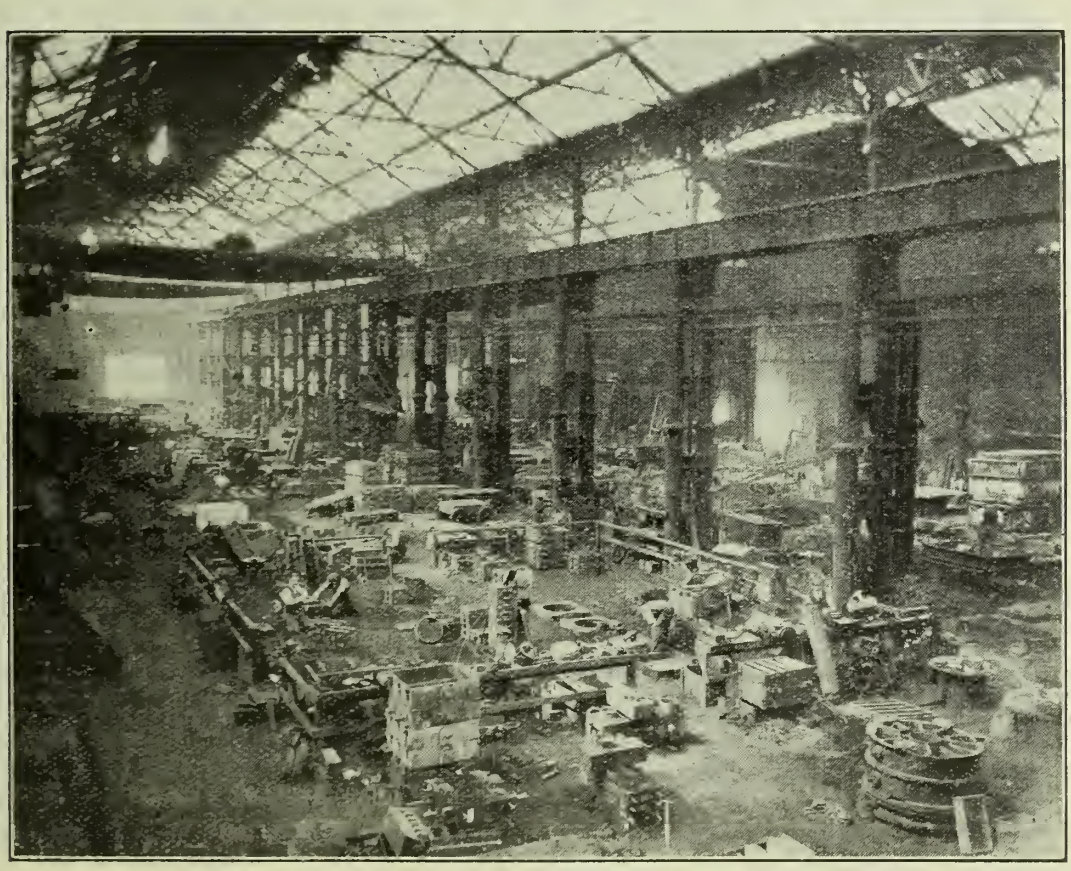


Fig. 2.—General View of the Foundry—Messrs. Fraser & Chalmers.

for the manufacture particularly of mining machinery for which they established themselves throughout the whole of the important mining fields of the world. Extensions of their activities rapidly developed, and they were the first British firm to take up the manufacture of impulse Rateau-type steam turbines in Great Britain, and to develop the important subject of pulverised fuel firing.

The products in these works include steam turbines, turbo-blowers and turbo-compressors; pulverised-fuel-fired "Bettington" boilers and pulverising equipment for the firing of other types of boilers and metallurgical furnaces. Material handling plants, embracing conveying, loading, unloading and storage plants for ores, coal, coke, ashes and grain, etc. Mining equipment for metalliferous mines and metallurgical works, including steam and electric winding engines; concentration, smelting and melting plants; gas-cleaning plant for the purification of blast furnace gases and complete rolling mills equipment.

General Machine Shops.

These are devoted to a great variety of mining machinery, including stamp mills, hardinge mills and the various other crushing mediums; concentration plant; steel and copper converters; blast furnaces and in particular large steam and electric winding engines. An interesting specimen of work noticed was a type of rotary kiln constructed of mild steel plates electrically-welded, which was in position for the machining of end plates.

Foundry.

Naturally this section of the works was most interesting to the visitors, being one of the most up-to-date and largest foundries in the South. The output covers iron casting ranging from the smallest of fittings, machine moulding as many as 40 castings in a moulding box, to castings up to 35-tons weight of the most difficult and intricate character. Special interest was centred in the casing of steam-turbine diaphragms where the nickel-steel blading is cast in special cast-iron and the various analyses of irons used in making up the foundry mixtures. The shop is divided into various sections for loam moulding, dry sand and green sand, and covers an area of 400 ft. × 450 ft. with two main bays and two side bays, and is situated in the centre of the works from which castings can be distributed to the various machine shops. The two main bays are served by six electrically-driven overhead-travelling cranes, 2 of 35-tons, 3 of 10-tons and 1 of 5-tons capacity. These are supplemented by four 7-ton hydraulic jib cranes and six 2-ton jibs, and a runway from end to end of the shop. Four cupolas are installed, ranging in melting capacity from 12 tons to 5 tons per hour, served by a Roots blower through a 20-in. pipe, with pressure registers both at the blast main and cupola in operation. There are 36 moulding-machines of various types, the largest running a load of 7 tons to the smaller hand-power machines. Four large drying ovens are installed measuring 20 ft. × 16 ft. × 28 ft., equipped with wagons for carrying loads of from 60 to 80 tons. One large stove is installed exclusively for oil-sand cores, and four smaller stoves for the smaller cores, with draw traps of the latest design, all the core wagons being pulled into and withdrawn from the stoves by mechanical means.

The whole of the power-machines are served by compressed-air service, which is laid throughout the shop and used in various auxiliary ways to aid production, such as driving sieves, chippers, hammers and drills, and also operating the moulding machines. Further, a very efficient shot-blast plant is also served by compressed air. The cupolas are served by a lift, conveying scrap and pig iron, with an elevator system for carrying coke to the charging floors, which have weighing platforms installed. Pig-iron, scrap and coke bins are situated in the immediate rear of the cupolas unloaded direct from the railway wagons by means of electric magnets and portable stackers, the metals being stacked separately according to analysis and grading.

Sand-mixing and handling-plant is situated in the centre of one of the side bays, so that equal distribution is given to every section of the foundry, and the new sand is delivered into this section through the side of the building direct from the store.

Turbine Machine Shop.

This shop comprises the complete manufacture, erection and testing of steam turbines up to 30,000 k.w. capacity in a single unit. Turbo-blowers and turbo-compressors for capacities ranging from 5,000 to 50,000 cub. ft. of free air per min. to pressures of 130 lbs. per sq. in. The shop is practically self-contained to produce the finished plant, including all details, heavy machine work being done on either side with the centre bay being laid out for testing and erection. On each side is a gallery which carries all turbine blade work, and the smaller detail parts. Machines seen on the erection pits, and in course of manufacture included turbo-alternator units of 18,750 k.w. and 10,000 k.w., down to small single-stage turbines running at high speed for condenser auxiliary drives. Also smaller size gear-driven D.C. generator sets, and steam turbines for driving through reduction gearing to main shaft lines for industrial works. Sections of a turbo compressor were seen for an output of 10,000 cub. ft. free air per minute at a pressure of 100 lbs. per sq. in., and in this connection it was mentioned that Fraser and Chalmers had recently completed the largest turbo-compressor unit manufactured in this country, having a normal capacity of 30,000 cub. ft. against a pressure of 120 lbs. with continuous overload of 25 per cent. Their largest turbo-alternator manufactured was stated to have a maximum continuous capacity of 23,500 k.w.

The visitors were able to examine in detail the production of steam turbine blading milled from nickel and stainless steel solid bars. Further, in seeing the method of balancing the rotor wheels and their testing and completion after inspection.

Power Plant.

After reviewing the manufacture in various stages, inspection was made of the works power plant of a turbo-alternator of 1,500 k.w. capacity running at 3,000 r.p.m., and operating in conjunction with rotary converters manufactured by the "Witton" engineering works. The steam raising plant comprised a complete installation of a "Bettington" pulverised-coal-fired boiler, utilising inferior class of fuel at the maximum efficiency, and operating at a working pressure of 500 lbs. per sq. in.

In general it was mentioned that the position of the G.E.C. was such that they were able to contract for complete power plant, manufacturing boiler plant, and both the mechanical and electrical sections of the power units. They have at present going through their shops one of the largest rolling mills to be manufactured in this country, being a 34 in. × 48 in. two-high reversing universal plate mill, the total weight of this mill excluding driving gear, being approximately 2,735 tons and overall length when erected 720 ft. by 72 ft. in width. They have also recently contracted a large order for Spain for material handling plant, and the general aspect of the works show that while the engineering industry might be termed as depressive, Fraser and Chalmers were fortunately contracting some large and interesting orders.

An excellent tea was then partaken of, at the invitation of the directors of the Company.

Address of Welcome.

Mr. F. W. Lewis (Works Manager), who presided, expressed the regret of the General Manager at not being able to be present; he had prior appointments which it was imperative that he should keep. The Company, said Mr. Lewis, esteemed the visit of the London Branch of the Institution of British Foundrymen as something of great interest to them, because, as a firm, they attached the very greatest importance to the foundry. Personally, he considered the foundry as the foundation on which the whole structure of the mechanical part of their products rested. Of course, he did not lose sight of the pattern shop. But it was of the utmost importance in the foundry business that there should be, first and foremost, a very close co-operation between the pattern shop and the foundry. He knew the subject of whether the "top dog" should be the pattern maker or the foundryman had been much discussed, but he was

not prepared to express an opinion. At any rate, with mechanical engineering the products of the foundry were the basis upon which the whole of the results rested, and he was convinced that the average foundryman had not yet realised the importance of his business to the extent that, steam practice, then their products were an absolute failure. As a mechanical engineer, and as one having had a little to do with foundry practice, he impressed upon the visitors the necessity of emphasising, not only to the moulders, but also to the rising generation, the apprentices in

Fig. 3.—Ready for Pouring a Large Turbine Casing—Messrs. Fraser & Chalmers.

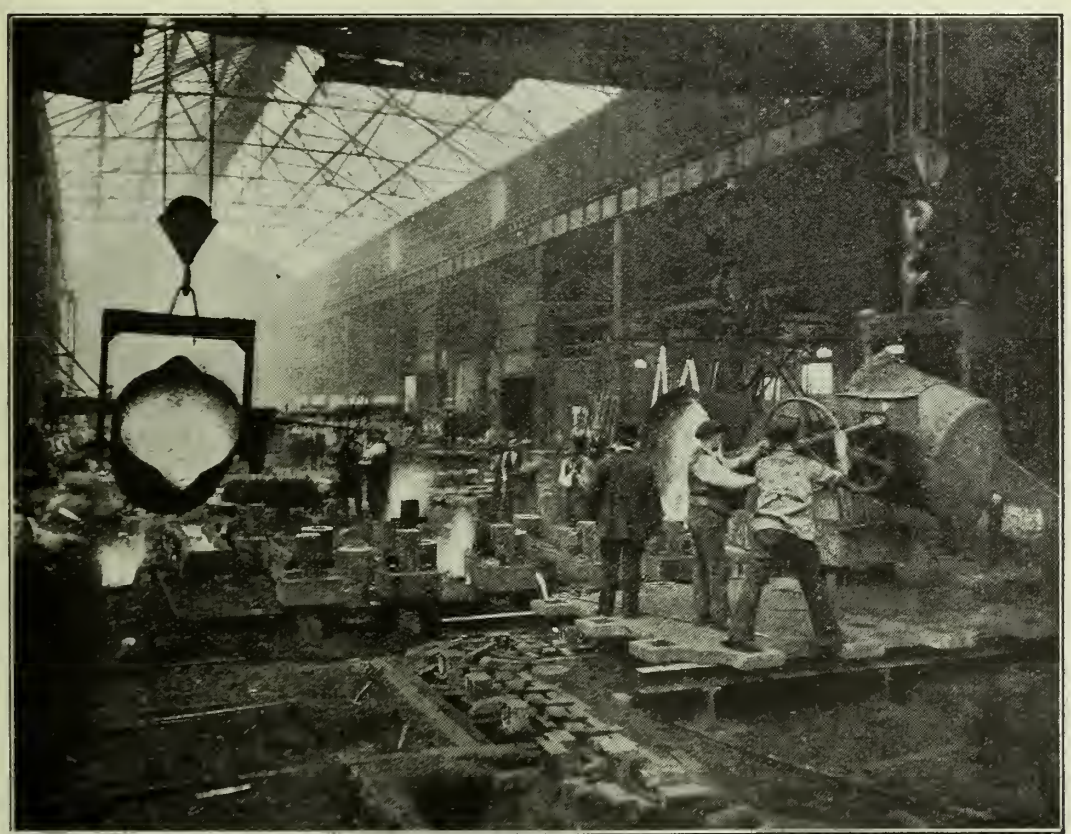


Fig. 4.—The Finish of the Pouring of a Large Turbine Casting—Messrs. Fraser & Chalmers.

perhaps, the mechanical engineers of this country had done. The mechanical engineers realised that, unless they could get castings of the right kind, of the right quality, and of the right finish, castings that would stand the pressures which the trend of modern practice demanded, and the temperatures which were coming into vogue in their works who were coming along to fill the ranks, the importance of the foundry industry. In that connection he was very pleased indeed to know that amongst the visitors there was a very large percentage of young men, and he hoped that, as the result of Mr. Lambert's Presidency of the Branch, there would be an increase in the

numbers of such in the Institution. He had been very interested in reading the able speech of the Branch President in The Foundry Trade Journal. He had called the attention of the members to the fact that he was not a foundryman in the true sense of the word. He (Mr. Lewis) congratulated the members of the Branch upon having elected Mr. Lambert to the position he occupied. He did so because he believed it was an indication of the taking of a broadened view by foundrymen, that they had realised that, whilst the foundryman had a most important function to fulfil, he must of necessity be somewhat dependent upon the metallurgist. He believed the day was not far distant when there would be closer co-operation than exists at present between the metallurgist and the foundryman, and when that day came—the dawn was already apparent—then engineers would have what they were seeking, namely, an improved product, one which would bear the increasing stresses which engineering materials were being called upon to bear. He suggested that there was room not only for the metallurgist but for research. His firm

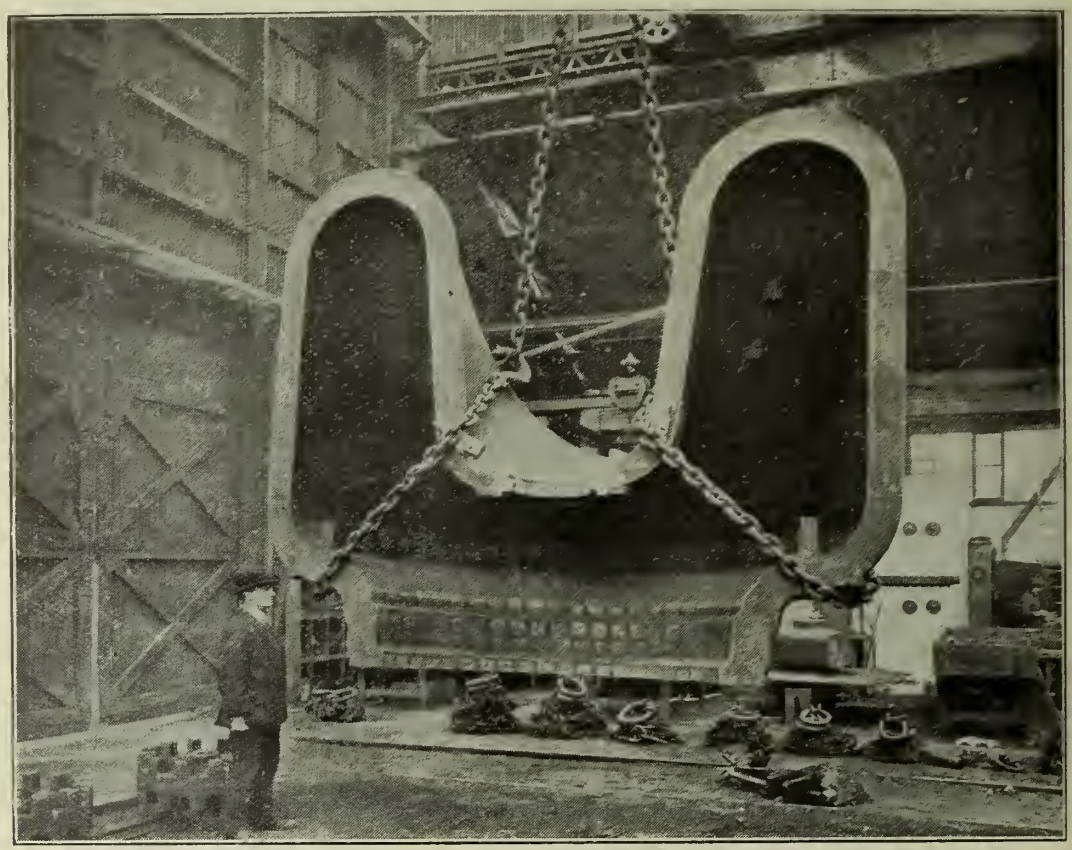


Fig. 5.—The Interior of the Casting, showing Marks Left by the Chills—Messrs. Fraser & Chalmers.

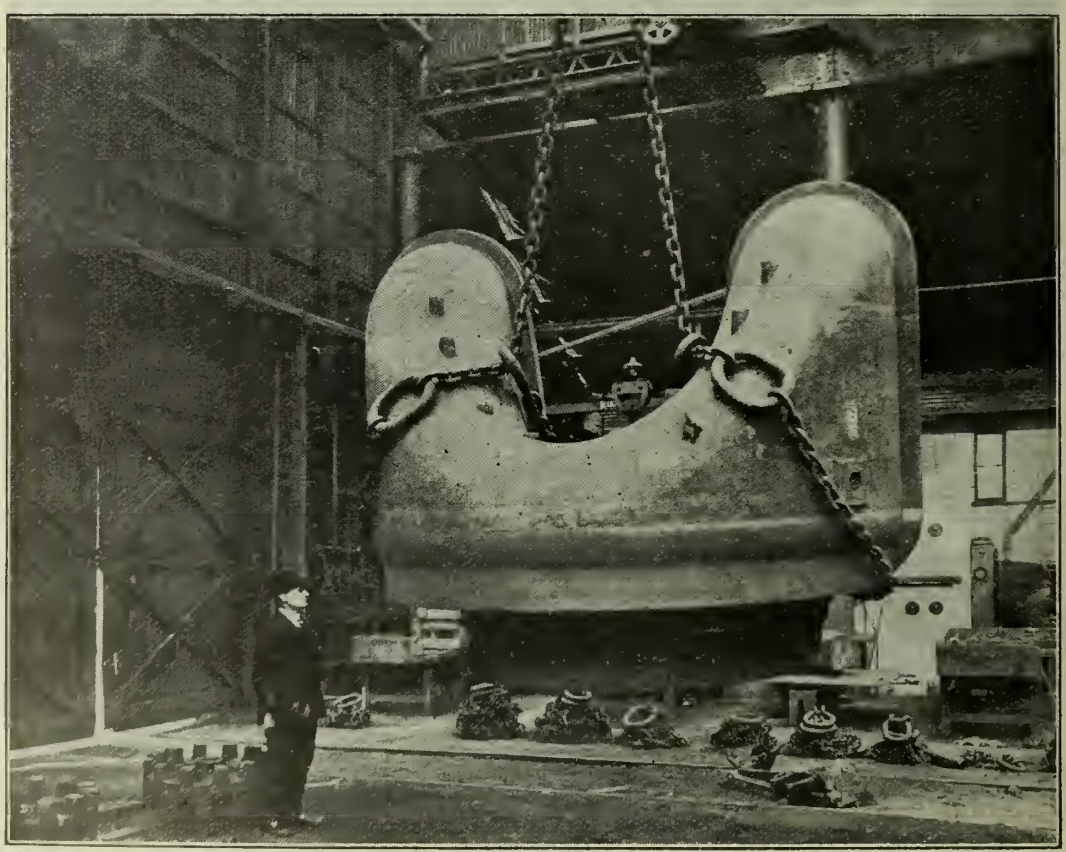


Fig. 6.—The Exterior of the Casting as it Left the Mould—Messrs. Fraser & Chalmers.

recognised that there must be the analytical chemist, and they recognised that they must have their laboratory, but, as a company, they recognised that they must also have a research laboratory outside the ordinary routine laboratory in the works. With this in view, the Company had put up what he believed would be admitted to be, by those who had seen it, one of the finest research laboratories existing in this country, under the able management of Mr. C. E. Patterson, of Wembley. The firm believed that there was a wide field for research. Cast iron was a most important metal, and one which, up to the present, was a necessity; but he looked forward to the day when they would have something better than cast iron which would fulfil for them that which cast iron could not fulfil, and which even cast steel could not fulfil; he believed that when they got it it would be the result of the closest co-ordination between the metallurgists, in the research laboratories, and the foundrymen, in the shops. When these two forces were amalgamated and pulling together, as was necessary, they would get a better product than had ever been turned out before. He suggested that the training of pupils and apprentices, and the bringing of youth into the foundry trades, was a matter which should receive closer consideration than it had received up to the present. He had had the pleasure of going round a great many foundries in this country, and he had been struck by one fact, namely, the comparative absence of young men taking up the foundry business and making it a life study. In the engineering side of the business it was found that in all branches there was a very large number of young men who were as keen as possible to understand their business, to get to understand the elements controlling their business, and to make themselves professional engineers, and he would be delighted to see an increase of that same spirit amongst the rising generation in the foundry. In conclusion, he hoped the firm would have the pleasure of another visit from the Institution in the not far distant future.

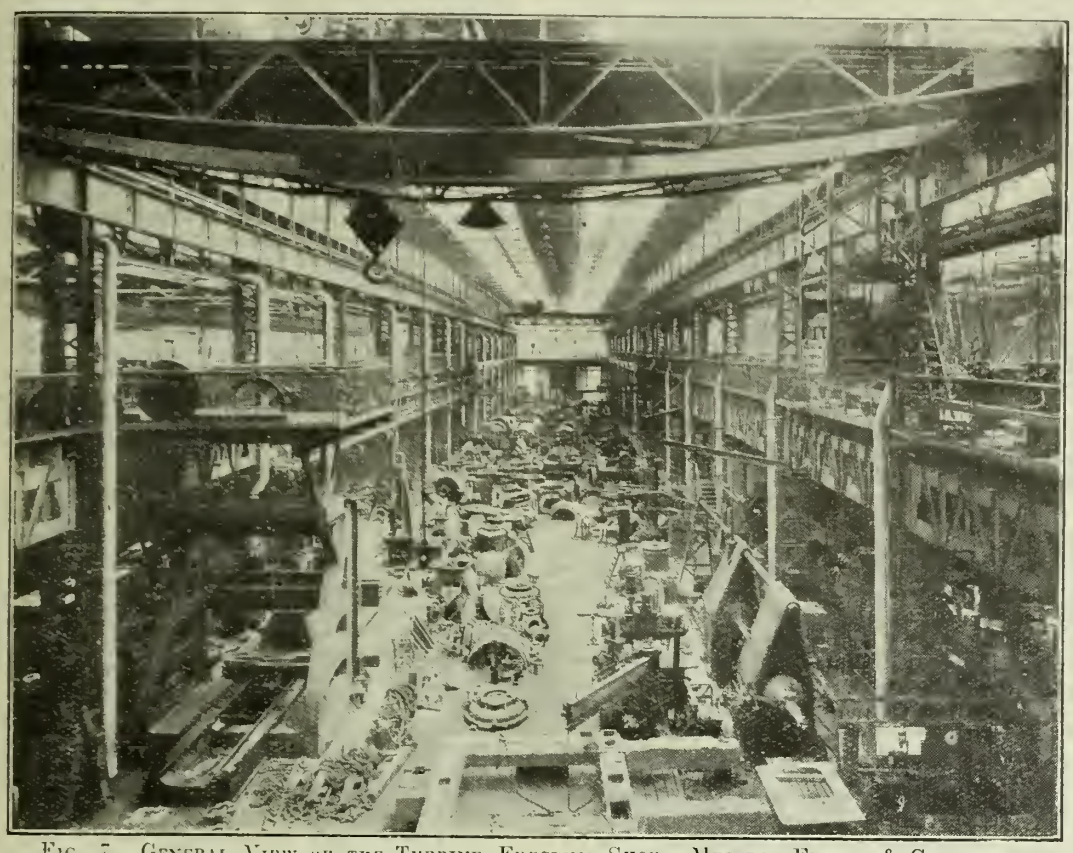


Fig. 7.—General View of the Turbine Erecting Shop.—Messrs. Fraser & Chalmers.

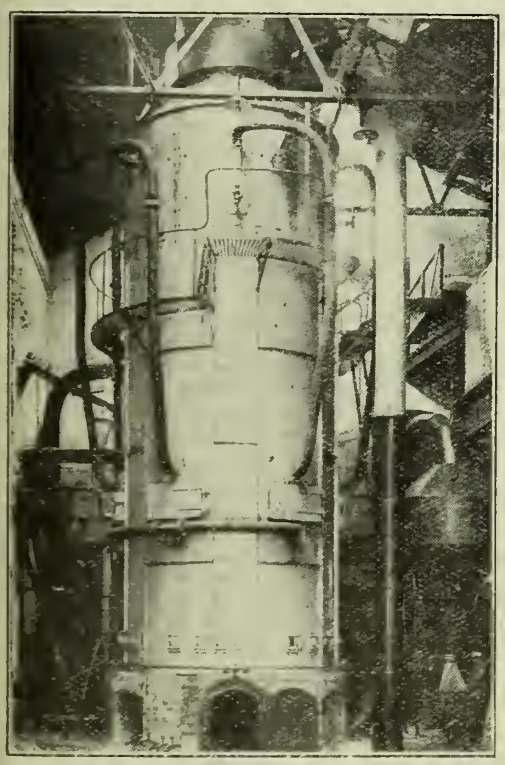


Fig. 8.—The Bellington Pulverised-Fuel Boiler—Messrs. Fraser & Chalmers.

The Institution and the Industry.

The Branch President, Mr. Wesley Lambert, then proposed a very hearty vote of thanks to the directors of Messrs. Fraser & Chalmers, to Mr. Lewis, Mr. Whiting, and Mr. Bartlett, and all those who had contributed towards making the visit of the members of the London Branch so pleasant, so interesting, and so instructive. He was very much indebted to Mr. Lewis for having sacrificed his Saturday afternoon for the members. As for Mr. Bartlett, they all expected him to be present, and had he not been they would have wanted to know why. The remarks which had just been made by Mr. Lewis, by reason of his earnestness, might almost be regarded as a sermon, and he hoped that all the members of the Branch would take those remarks to heart. In a conversation he had had with Mr. Lewis, he had asked him whether he knew of many foundrymen who had put their sons into the foundry, and he had replied that there were not many. He (the

Branch President) knew that too; but why? Was it because they were ashamed of their own trade, or of the conditions under which they worked? If so, he could only say that foundrymen now had it in their hands to improve those conditions, because the Institution of British Foundrymen was a recognised Institution, and in course of time would control the whole industry. The Institution could work towards improving conditions in the foundries, and the members must all recognise, from what they had seen that day, that it was necessary to pay very close attention to foundry problems. He had gathered that Mr. Lewis was proud of the castings made in that foundry. If he were proud of them, it was not because he laid claim to being the founder. He looked to Mr. Whiting, Mr. Bartlett, and their assistants, and therefore, if they had a works manager or a general manager who was proud of the castings made, it reflected to the credit of the foundrymen. The castings he himself had seen that day had struck him as being very excellent, as castings, and the iron was excellent. He again thanked the directors for having permitted the members of the Branch to visit the works. for having shown them the whole of the shops in the way they had done, and for having provided an excellent tea.

Mr. J. Ellis seconded the vote of thanks. He was very pleased indeed, as a foundryman, to hear Mr. Lewis indicate what his firm was doing in the way of research. The need for research was one of the things which the Institution, in its very early days, had started out to instil into the minds of the employers. They all acknowledged, as foundrymen, that on many occasions they did not know what was happening when wasters were in evidence, and because of that they had struggled very hard to get the employers to fit up laboratories for research work. There was very little laboratory work done forty years ago. If anything at all was done in the direction of research, it was done in the foundries by rule-of-thumb methods. When they had a waster they used to break it up, and one man would say there was a blowhole, whilst another would say it was not a blowhole but a draw. But they did not get at the scientific reason for it. In going through the foundry that afternoon, the thing that had struck him most was the beautiful skin on the castings. He had been in many foundries recently, and had found in use a pneumatic chipper chipping off the slag from the castings. Some of them looked as though they had come from a gravel pit. He had never been in a foundry in which he had seen so many good castings and so few defects as he had seen in the foundry of Messrs. Fraser & Chalmers. Following up the remarks of Mr. Lewis with regard to the importance of foundry work, he said he believed that if 100 moulders saw the casing which they had all seen in the foundry that afternoon, and had to make a similar one, 99 of them would not know how to start. It was a most intricate piece of work, requiring great skill and attention, and he believed that in that aspect the foundryman's work was not considered to be so important as it really is. Quite recently he had heard a managing director telling a visitor to the foundry that there was really nothing in foundry work; all that was necessary was to make an impression in the sand and pour the metal in. He asked them to imagine the result of defining foundry work in that manner

The vote of thanks to the directors of the Company, coupled with the names of Mr. Lewis, Mr. Whiting, and Mr. Bartlett, was accorded with enthusiasm.

Mr. Lewis, in a brief reply, said that the manner in which the visitors had responded more than compensated for any little trouble the Company had taken.

At the annual meeting of the Junior Institution of Engineers (North-Eastern Section), held in the Armstrong College, Newcastle, on October 24, Mr. Brackenbury (president) presented the silver medal for the best paper to Mr. J. Calderwood for his paper on ship propulsion. Mr. Brackenbury, in his address, after giving some results of experiments in the brazing of nickel steel, spoke of the education of the engineer and praised continuation classes.

A German Steel-Maker on the Situation.

Herr Peter Klöckner, in the course of his address to the annual general meeting of the Lothringen Ironworks and Mining Company on October 12, remarked that while the depreciation of the mark in recent months had resulted in an influx of foreign orders, it was now playing havoc with finance. The working capital of concerns was no longer equal to the enormous increases in prices, and it would only be possible for industry to find wages and salaries for a short time longer and keep the works going. In many cases attempts were being made by concerns to help themselves by making the conditions of payment more strict, but this expedient could not be commended. It would find imitators, and if generally carried out would eventually lead to economic collapse. The directors of the Klöckner Group held the view that large and small concerns must hold together in such a crisis of credits and no exceptional terms of payment must be enforced, but efforts must be made to maintain business as long as possible by a system of barter.

During the past year the nation had endeavoured to turn out more work, but the additional output had proved insufficient. The overtime agreement in the Ruhr mining district had only yielded small results, and had at the same time considerably increased the pits' costs of production. In the case of the Company's own miners, about 90 per cent. were working overtime, partly two hours on three days and partly one hour on six days a week. But the extra production was inadequate. It would be necessary so to increase the output as to oust foreign coal and have sufficient coal available to permit the steelworks to expand their output and thus make the importation of foreign steel unnecessary.

The systematic enforcement of the eight-hour day, Herr Klöckner proceeded, was hampering economic life, and prevented appreciable improvement. The applications for increases in wages and salaries, which were now being made not only monthly, but even fortnightly, had not in a single instance been accompanied by a voluntary offer of doing more work. It was no wonder their course was downhill, as all increases in wages immediately advanced the cost of living and further depreciated the mark. The Federal Government had frequently asked the nation to work harder, but had hitherto taken no steps to abolish the eight-hour day. The time would come when hunger would force them to work harder.

At present the German coal and iron industries were fully occupied, and foreign countries were still able to purchase goods, although even neutral countries in Europe suffered from the consequences of the war. On the other hand, their oversea business was still very active, and orders continued to arrive from British India, China and Japan, while Great Britain remained one of their customers. There was in general more work on hand than the works could execute, but most of the establishments were working short time, owing to the scarcity of coal and coke.

As regards foreign markets, the speaker stated that increasing competition was being offered by Belgium and France, the industries of which countries were assisted by export and freight bonuses, whereas the German works were greatly hampered by export embargoes and taxes. The inland demand continued large, and many industrial concerns were occupied in the carrying out of work for renewals and repairs.

The decision of the Admiralty to invite tenders for battleships has caused general satisfaction. Among the firms tendering are Sir W. G. Armstrong, Whitworth & Company, Limited, Palmers Shipbuilding & Iron Company, Limited, and Swan, Hunter & Wigham Richardson, Limited. In addition, Palmers Shipbuilding & Iron Company, Limited, Hawthorn, Leslie & Company, Limited, Wallsend Slipway & Engineering Company, Limited, and Parsons Marine Steam Turbine Company, Limited, will tender for machinery, and Sir W. G. Armstrong, Whitworth & Company, Limited, for armaments.

Estimation of Minute Percentages of Iron in Foundry Materials.

By "Celsian."

To determine minute percentages of iron in materials such as silica bricks, sand, limestone, etc., the sulphocyanide colorimetric method is generally preferred. Among other advantages, this method is claimed to secure accurate results in presence of large quantities of impurities. One of the first analytical books which gave a description of this estimation was Beringer's "Text Book of Assaying."

Further investigations of the most accurate method of applying the determination have since been made, and some of these, as used in works practice, are here given.

Usual Method.

The method consists in first dissolving the material in a suitable acid, or where of an insoluble nature, fusing with a fusion mixture and extracting the melt with water, and acidifying. A solution of permanganate of potash is added until the solution is tinted, after which it is boiled, cooled, and diluted.

Potassium sulphocyanide is then added, and the red coloration produced compared with that of a standard iron solution prepared under similar conditions. The assay solution is diluted until its depth of colour is identical to that of the standard, and the percentage of iron present computed by proportion. This is the description usually given in analytical text books, together with a few details of the effects caused by altering the conditions.

According, however, to the researches of two well-known chemists, the red coloration developed is not necessarily proportionate to the percentage of iron, but is greatest when the sulphocyanide and iron are present in equal proportions. The inaccuracy is due to the fact that the red coloration, formed by a ferri-potassium sulphocyanide which is decomposed by water, cannot serve as a guide to the amount of iron present, since the intensity is a function of the dilution.

A double salt is formed which on dilution is converted to another double salt of iron and potassium sulphocyanides. Solutions of the latter salt are lighter coloured, and are tinged with orange. It has also been proved that solutions of ferric sulphocyanide and coloured solutions of double tartrates and acetates of the alkalies are subject to progressive dissociation of the pigmentary salt, and therefore impossible of comparison with standards in colorimetric estimations. Despite the fact that these inaccuracies are known, the method is still largely adopted, but many precautions are taken that the standard and assay solution are compared under exactly similar conditions.

Best results are secured by using cold solutions, and making the comparison immediately after addition of the potassium sulphocyanide. An excess of free acid tends to increase the depth of colour produced, particularly with nitric acid, as nitrous acid itself is capable of forming a red colour with potassium sulphocyanide. The method is seldom capable of producing quite so accurate results when phosphorous or arsenic are present, as the effect of these requires to be eliminated by addition of an excess of hydrochloric or other acid. Copper is one of the few metals which are capable of interfering with the colour produced, but this metal is seldom found present in materials such as limestone, fireclay, silica bricks, etc. If any copper is present it is readily noticed, as the solution will have a greyish-green tint, which may then be tested with ammonia.

The estimation takes longer to perform when the latter impurity is present. One method consists of precipitating the iron as arsenate, redissolving in dilute hydrochloric acid, and proceeding as before. Very few processes in which the iron has first to be precipitated, before applying the colorimetric assay, will yield satisfactory results.

The following description gives details of a modified method which has furnished the best results up to the present time.

Method Advocated.

After dissolving the material by one of the usual methods, the solution is diluted considerably and made to contain about 5 per cent. of nitric acid. The solution is treated with potassium sulphocyanide, and when the dirty reddish colour develops, about 10 c.c. of ether are added and the liquor thoroughly shaken up.

The tubes used for the test are made of very clear glass, graduated, and provided with emery stoppers.

By shaking up with ether, the sulphocyanide compound of potassium, iron, etc., is decomposed and the iron sulphocyanide dissolved out alone.

The aqueous solution should be completely decolorised if the proper conditions have been adhered to.

As the colour of the ethereal layer deepens on standing, it should be allowed to rest for some time before comparing with the standard iron solution.

The standard iron solution preferred for this work contains about 0.01 gm. of iron per litre, and is made up by dissolving ammonium ferro-sulphate in distilled water containing a little sulphuric acid.

All reagents used throughout must be carefully examined for traces of iron, and their combined result subtracted from the amount of iron present in the assay solution.

Contracts Open.

Bagdad, November 30.—The Ministry of Defence, Bagdad, invite tenders for supply of 980 extra large stirrup irons (5-in. tread) and 420 large stirrup irons (4¾-in. tread) of British Army regulation pattern, standard, and quality. The Department of Overseas Trade (Room 49), 35, Old Queen Street, London, S.W.1.

Barnsley, November 6.—Supply of about 60 tons of cast-iron pipes and specials, 8-in. and 3-in. diameter, for the Town Council. The Waterworks Engineer, Doncaster Road, Barnsley.

Dublin, November 13.—Stores, for the Great Northern Railway (Ireland) Company. Mr. J. B. Stephens, secretary, Amiens Street Station, Dublin. (Fee, 1s.).

Johannesburg, January 2.—Supply of tramway points and crossings, for the Municipal Council of Johannesburg. The Department of Overseas Trade (Room 50), 35, Old Queen Street, London, S.W.1.

Leadgate, etc., Durham, November 20.—Supply of approximately 2,825 straight pipes, 9-in. internal diameter, cast vertically in dry sand moulds, for the Durham County Water Board. The Engineer, Bishop Auckland.

London, S.E., November 17-23.—The High Commissioner for India is inviting tenders for supply of (2) cast-iron pipes, socket and spigot, 15 in.; (3) railway wheel turning lathes, 48 in.; (4) d.c. low-tension three-core and two-core cables; (5) flexible steel wire rope, galvanised and ungalvanised; (6) copper tubing; (9) buffers, wrought iron, and washers for buffer springs; (10) axle-boxes, malleable cast iron or cast steel for carriages and wagons. The Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. Tenders by November 17 for Nos. 2 to 4, and November 23 for Nos. 5 to 10.

Manchester, November 14.—Supply of anti-friction white bearing metal, for the Tramways Committee. Mr. H. Mattinson, general manager, Corporation Tramways, 55, Piccadilly, Manchester.

Maldon, November 14.—Supply of about 1,227 yards of 3-in. and 440 yards of 2-in. cast-iron pipes, for the Maldon Rural District Council. Mr. W. Almond, surveyor, 6, Market Hill, Maldon, Essex.

Forges et Aciéries du Nord et de l'Est.—This French concern (share capital, 77,425,000 fcs.) reports for the financial year, 1921-1922, net profits amounting to 630,936 fcs., after certain allocations. There is to be no dividend. This amount, as well as the sum brought forward from last year, 1,355,189 fcs. (say £33,200 in all), are to be carried forward to next year.

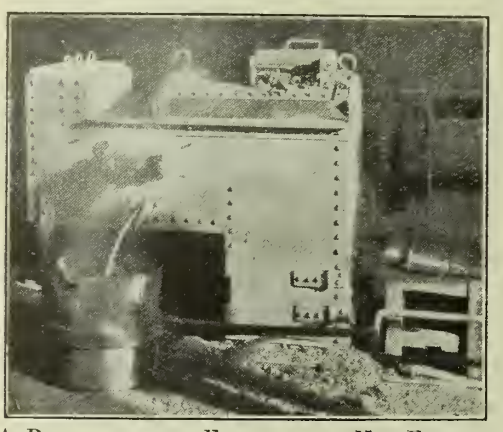
Reverberatory Furnace for Non-Ferrous Metals.

By the courtesy of Messrs. Worthington-Simpson, Ltd., our representative was permitted to inspect the air-blast reverberatory furnace installed in the brass foundry at their Newark Works.

This furnace of one-ton capacity was the first to be built under the patents of British Reverberatory Furnaces, Limited, 82, Victoria Street, London, and as it constituted such a revolutionary departure from all existing methods of melting non-ferrous metals, it was regarded in the light of an experimental installation with which to prove thoroughly the system on commercial lines, and in the light of experience so gained introduce into the design such modifications and refinements as might from time to time be considered advisable. The furnace has, however, now been in operation for approximately 12 months under everyday conditions, during which time it has proved itself an essentially sound and practical proposition, fully justifying the sanguine anticipations of the inventors without the necessity of modifying in any way the essentials of the original design; indeed, the only alteration made in the structure is the position of the firing hole, which has been more conveniently placed at the top instead of, as at first arranged, in the side of the combustion chamber.

General Construction.

The general construction of the furnace will be understood from our illustration, which, however, shows the ½-ton size. The casing of the original furnace was made of cast-iron in order to reduce



A Reverberatory Furnace for Non-Ferrous Melting.

the costs of structural alterations, had such proved necessary; normally the casing will be of steel plate as shown. The working bed of the furnace is provided with a vaulted roof, it is separated from the combustion chamber by a fire bridge, and communicates through a restricted passage with the uptake, which is also the metal feeding hopper. The motor-driven fan is attached to the back of the combustion chamber and delivers the blast at about 6-in. w.g. beneath the fire bars. The fan control is housed, as shown, on the end of the furnace adjacent to the metal hopper. The inspection door provided in the side wall above the tapping hole also fixes the limit of the full charge for the furnace.

Charge Sheets.

The furnace has given remarkable results in operation. We are indebted to British Reverberatory Furnaces, Limited, for the following figures. On October 15 they demonstrated the one-ton furnace at Lowfield Engine Works, to Mr. Spittal and Mr. Whiteman, of Messrs. Allen Everitt, Limited, of Birmingham. The following charge sheet was obtained:—

Gun-metal Charge Sheet.

Pre-heated furnace with 75 lbs. of coke.
1.10. Re-charged furnace with 75 lbs. of coke.
1.13. Charged gun-metal, consisting of hard scrap and copper, 13 cwt. 1 qr. 8 lbs.
1.58. Re-charge, 90 lbs. of coke.
2.3. Alloy additions made.
2.15. Metal tapped.

Copper Melting Charge Sheet.

2.56. Charged 60 lbs. of coke and 6 cwt. of scrap and copper (98 per cent. copper).
3.09. Bath completely melted, when we began "polling" in about 10 minutes. The visitors took samples from the furnace with a small ladle, which were tested and gave satisfaction.

More Gun-metal Charges.

On October 11 the furnace was demonstrated to Mr. Collyer and Mr. Miller, of Messrs. Adams & Company, Birmingham, and the following result was obtained:—

Pre-heated furnace with 87 lbs. of coke.
2.0. Charged 87 lbs. of coke.
2.2. Blast started.
2.5. Metal charged, consisting of No. 2 gun-metal mixture, containing about 80 per cent. copper, 20 cwt. 0 qr. 18 lbs.
2.22. Re-charged with 116 lbs. of coke.
2.35. Metal gone through the hopper.
2.45. Alloy additions made.
2.50. Metal tapped.

Advantages.

The elimination of crucibles, though important, is by no means the most important advantage of the furnace under consideration. In the first place the economy in the matter of ordinary charging is really considerable. The hopper in this instance will take pieces of metal up to 500 lb. in weight, whilst runners and other scrap metals can be utilised without having to cut them up into small pieces, as would be necessary with the crucible with which the heat would not be sufficient to melt such pieces in a reasonable time, even assuming the crucibles were able to stand the stresses incidental to such practice. The question of losses by volatilisation and oxidation are vital considerations, such losses, when melting yellow brass in the crucible, may easily average from 5 to 7 per cent., whilst losses of from 3 to 4 per cent. may be regarded as a fair covering average for the whole of the usual non-ferrous alloys. Our representative was informed that the loss in the furnace under notice averages only 2 per cent., and as the metals most subject to waste are usually the most expensive ones, economy in this direction is of paramount importance. Volatile losses are further reduced by the fact that it is unnecessary to add zinc and other quickly-wasting constituents until the ingot copper or scrap has reached the fluid stage. The greater heat available in the furnace also renders it unnecessary when casting phosphor bronze to add, as is usually done, an excess of phosphor copper, in order to obtain an alloy sufficiently fluid for casting.

The separation of the fuel from the metal serves to reduce to a negligible minimum loss by oxidation.

Finally, when casting out, the furnace can be tapped like an ordinary cupola, the metal remaining in the well being maintained in perfect condition by a gentle blast, a valuable feature which is, of course, wholly impossible with the crucible furnace.

Demonstration Results.

Our representative had also an opportunity of inspecting the ½-ton and 5-cwts. furnaces. In the first-named a charge of ½ ton of copper was melted and drawn off in 30 minutes, 1 lb. of coke being used per 5 lbs. of metal melted. The five-cwt. furnace is likely to prove the most popular size for the small foundry, as also for the general engineering shop casting their own brasses, etc. This furnace occupies a floor space of only 5 ft. × 2 ft. The furnaces, being entirely self-contained, lend themselves very readily to portability, to which end they can be supplied upon a wheel base, a very convenient arrangement making it possible to pour direct into the moulds and thereby effecting a saving both in time and labour.

Our representative had an opportunity of witnessing a demonstration with the ¼-ton furnace.

The fire was lighted in the furnace at 10.30 a.m., but owing to the foundry not being ready for the metal, blast was not put on to the furnace till

1.45 p.m., up to which time 41 lbs. of coke had been charged into the fire box.

First Melt.—The weight of metal charged was 4 cwt. 3 qr. 15 lbs., and consisted of ingot and scrap copper. The following time-table gives details of the working:—

1.47. Charging commenced.
1.59. Re-charged furnace with 31 lbs. of coke.
2. 6. Finished charging metal.
2.14. Additions made.
2.20. Tapped into ladle.

Second Melt.—The weight of metal charged was 4 cwt. 3 qr. 4 lbs., and consisted of heavy copper scrap:—

2.25. Re-charged furnace with 31 lbs. of coke.
2.28. Commenced to charge metal.
2.42. Re-charged furnace with 31 lbs. of coke.
2.52. Completed charge of metal.
2.58. Additions made.
3. 5. Tapped into ladle.

The time taken in charging the metal in the second melt was due to much of the scrap being of a size above the width of the metal hopper on the furnace, although fairly light in section. It would be more profitable to put such material under the shears before charging.

Some Notes on the Production of Sound Castings.*

By Christian Kluytmans.

The amount of moisture in the air supplied to a cupola is an important factor in fuel consumption. When foggy weather is prevalent filtration of the air to free it from the watery particles held in suspension will considerably increase the efficiency of a cupola. No open coke fires should be in the neighbourhood of the blower intake, for they produce large quantities of CO_2 which would be drawn in and delivered to the cupolas, so cutting down the supply of oxygen. The volume of air is of the highest importance, and should be considered from the point of view of the amount of oxygen delivered, yet it frequently receives less attention than any other factor.

A French writer considers the factors in the following order: (1) Hourly production; (2) blowing plant; (3) coke; (4) cupola. Starting with (1), the amount of air necessary to burn the maximum quantity of coke (per unit of air), which will melt the greatest quantity of iron is then based on the three factors—iron, volume of a given time. The dimensions of the cupola are air, and weight of coke.

From the composition of the air it is known that to obtain 1 volume of oxygen there must be 4.347 volumes of air. It is easy, then, to find what weight of coke can be burnt with a blower giving the fixed volume of air. The composition of the coke must be known so that the quantity of oxygen required for the complete combustion of its ingredients can be calculated. A coke of good quality, high in fixed carbon and low in ash, will utilise more oxygen than will a poor coke, low in carbon and high in ash. If the same volume of air is delivered in both cases then there will be an excess of oxygen when the poor coke is used, and consequently oxidation of the iron. The use of an inferior coke necessitates a larger proportion of fuel in the charge. Poor coke, too, being friable, settles into masses in the furnaces and there is danger of the air short-circuiting through the gaps leading to great waste of heat and oxidation of the metal.

Position of Blower.

The best position for the blower is as near as possible to the cupola, and care must be taken to see that the delivery pipes give sufficient air at the cupola with as little loss of pressure and volume as possible. Authorities differ as to the ratio between the area of tuyeres and that of the greatest diameter of the cupola; some say 1/10, others 1/7, and, in England, 1/5; it is always easier to reduce the area of the tuyeres than to increase it. A suitable indicator from which the pressure and volume of air can be determined at a glance is very useful, and it is essential that the blast should always be consistent. To maintain an even zone of heat the air must be delivered equally from all sides, and it would seem that two rows of tuyeres are better than one for this purpose. With two rows it is easier to deal with a charge that is "hanging" in the furnace, because the hottest zone can be raised to re-fuse the frozen part.

Since the blower is delivering a constant volume of air at a constant pressure, the cupola should be burning a corresponding weight of coke which, in turn, should provide the heat units to melt a corresponding tonnage of iron. The output calculated from these factors gives a sound basis for comparison, and if the actual output falls far short of this figure the cause should be traced and removed.

Height of Cupola.

The height of a cupola is generally taken as four times the diameter; in France a minimum of five times is taken. The greater height allows for the burning of the CO and saving of heat. In considering the effective diameter of the cupola it should be noted that increase of diameter means reduction of air pressure, but also means a thinner fuel bed, for which the air pressure may then be too great. For a smaller diameter the opposite is the case. Increase of diameter may result from excessive rate of melting, whilst hangings and "scaffolds" will lead to a reduction of diameter. In either event the blast indicator will at once show the variation and the necessary steps may be taken. The operation of charging the cupola should be based on the quantity of air, which determines the weight of coke that can be burnt. The proposition of iron is then determined from the heat available; any change in this proportion leads to variation of the quantity of air and inefficient working.

Cold Metal.

When the metal taps cold and sluggishly the proportion of iron is probably too high, or, if the proportion is correct, the pieces are too large. In the first case the weight of metal charged must be reduced; obviously the weight of coke cannot be increased without also increasing the amount of air which would lead to further trouble. Excess of coke leads to incomplete combustion and irregularity of melting in the fusion zone. When starting up a cupola it is better to make up the early charges with the pig in small pieces. When large pieces are charged—the furnace must be thoroughly hot—it is better to surround them with smaller pieces, which, melting first, help to bring down the big lumps. This question of charging according to fixed rules is very important, and has a great effect on the final result. In determining the weight of charges, liberal allowance must be made for the heat losses due to radiation, incomplete combustion, etc. Rather more than double the number of heat units theoretically required to melt the iron must be supplied. Naturally, when starting a cupola from the cold the proportion of coke must be increased, and that of the iron diminished until the furnace has become thoroughly hot. The remainder of the Paper is devoted to chemical reactions and microstructure.

* A Paper presented to the Nancy Meeting of the French Foundrymen's Association.

Dolomite for Refractories.

Briquettes containing 90 per cent. dolomite and varying percentages of iron oxide and clay have been burned by the United States Bureau of Mines at the ceramic experiment station, Columbus, Ohio. Slaking-time tests were made, and the results plotted. The slowest slaking mixture was selected for making into bricks which were burned to a sufficiently high temperature to render the lime inactive. Bricks with a high fusion temperature and high specific gravity, great mechanical strength, and low porosity were the result. The work is being continued, using varying percentages of dolomite to determine the non-slaking areas over the entire field.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

On Saturday, October 21, Mr. H. J. Young (Branch-President) gave a lecture on "The Problem of Grey Iron Castings," which was published in The Foundry Trade Journal of December 22 and 29, 1921.

"THE PROBLEM OF GREY IRON CASTINGS."

Mr. Young, before commencing his lecture, said the Paper was originally read before the Institute of Marine Engineers, and was, therefore, a Paper for engineers. It was his intention not to actually read the Paper, but to give it in a conversational manner and from the educational point of view.

Discussion.

Mr. Wise said that, as one there to be taught, he hoped Mr. Young would bear with him in a few remarks. They were told that what they wanted was scientific control, but Mr. Young did not mention whether it meant scientific control chemically or physically. The reason he mentioned this was because for some years he had been responsible for the output of a certain class of work which was turned out under scientific control, and, although their chemical analyses were fairly constant, nevertheless, physically, they had great fluctuations after, and sometimes before, they left the foundry. That chemical analyses only will control results had not been his experience, but, at the same time, he did not want to give the impression that he was not in favour of chemical analyses.

He also mentioned the graphitic plates, and asked whether Mr. Young held the opinion that carbon influenced the growth of cast iron, because he himself was of that opinion. Once, when they were having trouble with growth in pistons, they had test-bars taken and measured and reheated, and they found that if they decreased the phosphorus they ran greater risk of growth. He then thanked Mr. Young for his excellent Paper, and said that the more educational Papers of this kind that were given, the better it would be for foundry trade in general.

Mr. Lilley said that he had listened with great interest to Mr. Young's Paper, and that he was a firm believer in scientific control. He would like to know if Mr. Young could tell him how to control 200 tons of pig-iron; whethor each pig is analysed separately.

Changed Foundry Conditions.

Mr. Paulin said that he was very grateful for the plain way in which Mr. Young had made clear the effects of the different metalloids on the casting. He spoke of the effects of the increase of sulphur above the proper amount, and said that, as long as an increase in the manganese content took place, the sulphur was not really harmful. Did Mr. Young confine that statement to such a casting as a liner, or did the same thing apply to a wheel? He appreciated Mr. Wise's criticism, as it dealt with the ideas which are in many people's minds as to the value of chemical work in the foundry, but at the same time he thought that the time was past when one need question as to the value of the chemist in the foundry. In the past people have been working in the dark, the good results which were obtained in the olden days being possibly due to the fact that the pig-iron was purer than it is to-day. There is no doubt that if the foundryman who made good castings in those days was given the material we have to use to-day, he would not have been so successful. The people who have in the past done without the chemist should not necessarily still believe that they can do without him.

He would be very much interested to know if the experience Mr. Young obtained regarding the test-bar taken from the liner casting, and which proved to be almost the same as the actual test, cast with the casting, as regards physical tests, could be expected to be repeated with any casting, as it had always been, as far as he knew, accepted that if a test-bar was taken from a thick portion of a casting it could not be expected to give the same physical results as the test-bar cast in the ordinary way.

Mr. Logan stated that his experience regarding pig-iron variations was similar to that of Mr. Young, and gave analyses of one of the pig-irons mentioned in the tables where the silicon had varied 1½ per cent. in different consignments over the last two and a-half years. He considered that the sulphur-manganese balance should be more widely known and very fully investigated, as, although himself a believer in its application, he had come across apparent exceptions for unknown reasons. He gave one instance where two irons, made from the same mixture and with the same pig-irons, gave very good bars, and, later, very bad bars—the only differences in composition being that of sulphur and manganese. The good bars contained 0.160 per cent. sulphur and 0.33 per cent. manganese, whilst the bad bars contained 0.132 per cent. sulphur and 0.54 per cent. manganese, from which one would expect the good bars to be the bad ones, and vice versa.

Mr. Matthews did not agree with Mr. Young in his statement that very little reliable work has been done upon the cupola, because he thought a considerable literature had grown up around the subject. In this connection Mr. F. J. Cook's Paper before the 1913 London Conference should be noted.

The Author's Reply.

The President, in answer to the discussion, said that Mr. Wise had seemed to intimate that he had suggested that chemical analyses were all that were necessary to get good iron, but he would like to point out that there are people called analysts in this country and people called chemists, and the average analyst is not a chemist; he has yet to become one. Analyses are made in order to learn accuracy. There are a great many works which analyse their iron and get very little good out of it, because they do not know what to do with the results. There are ten or twenty elements or compounds for which we do not analyse; therefore, he did not think that analysis as we know it will control iron. Everything must be estimated before one can safely use the expression "cannot be controlled by analysis."

Mr. Wise had brought up the question of the sulphur globules in the iron. He (Mr. Young) was afraid that he had been too free in speech, as the globules consist of iron and manganese-sulphide—practically a slag—and float about and very often come to the top. By adding ferro-manganese to iron, the sulphur is sometimes partially removed and comes out as slag, which is far less harmful than unbalanced, and which explains how, with sufficient manganese, one can keep the sulphur under control.

Growth of Cast Iron.

With reference to the question of growth, the carbon and the carbides determine the strength and properties of the iron, but, on the other hand, the silicon, sulphur, phosphorus, and manganese, etc., control the carbon and carbides. The plates of graphite shown on the screen are really minute spaces filled up with carbon. During the process called "growth" they expand and contract, and reactions take place which cause the iron to swell, but the composition of the iron would determine how much that swelling takes place.

In reply to Mr. Lilley, Mr. Young said that if one buys a number of different brands of pig-iron, analyses and mixes them thoroughly, and puts into the mixture three or four or more pig-irons, a very good average would be obtained. He advised Mr. Lilley, when he was making special castings, to procure some pig-iron that does not vary so much, for, as long as the iron is mixed properly and scientifically, it is all right.

Regarding Mr. Paulin's question as to whether the mixturo used for a liner is suitable for a wheel casting, he thought that high and balanced sulphur could be used for a liner, but not for a wheel. If one gets sufficient manganese, the sulphur can be controlled, but it was safer for average foundrymen not to try high sulphur without the help of a chemist.

Mr. Logan said that he had had cases of finding better metal with low manganese-content than

with high manganese-content. That may be so. It does not follow that, because one has got the proper amount of constituents in their iron, that good results will be obtained. If the manganese-content is good, so ought the metal to be, but there might be other reasons for its failure, such as temperature, cupola practice, etc., or there may be an element not analysed for that may account for it.

In reply to Mr. Matthews, Mr. Young said that they had been looking round for five or six years and had not been able to find an instrument that would usefully tell the variations volume of the air passing into the cupola.

Mr. Wise proposed a vote of thanks to Mr. Young for his Paper, which was accorded in the usual manner.

LANCASHIRE BRANCH.

"HANDLING OF FOUNDRY MATERIALS."

At a meeting of the Lancashire Branch, held at the Manchester College of Technology on October 7, the Branch-President, Mr. J. Haigh, of Wakefield, read a Paper upon the "Handling of Foundry Materials" (particularly iron), in which he described the manner in which this problem was dealt with in a large foundry receiving, in normal times, more than 1,000 tons of material per week. He illustrated his remarks with a large number of lantern slides and by reference to plans, one of which showed the buildings with railway lines, narrow gauge track, storage bins, etc., and the other the interior arrangements and the overhead equipment.

Importance of Transport.

Mr. Haigh said the question of the best method of transporting and handling foundry material was a very large one, and in many respects difficult. Outside the foundry, inefficient transport was a frequent cause of annoyance and delay; inside, bad lifting tackle and insufficient handling facilities gave rise to grievous complaints. There were probably more make-shift arrangements in the foundry than in any other department; even at the present time, in some cases in this country, iron, coke, etc., were carried by men on to the charging platform.

The cost of putting materials into the yard was often determined by the geographical situation, the relation of the foundry to the railway sidings or the canal wharfage. In the case he was dealing with all the material was received by rail, and, if storage accommodation was available, it went directly to the place where it was to be used. Direct siding accommodation, or proximity to a railway, gave a firm a primary advantage over another firm situated farther away which had its materials carted in and out of the works. This advantage, however, might be lost if, owing to faulty arrangements inside the works, material had to be handled and rehandled repeatedly. All material, when received, should be stored as near the place where it was to be used as was possible.

A foundry equipped with good lifting appliances was likely to turn out work more quickly and expeditiously than one badly equipped. In many cases the craftsmanship of the moulder rose superior to his environment, and many good castings were produced in badly equipped foundries. This, however, was no apology for bad tackle. One should be alive to the use of modern equipment, and able to take advantage of it when the opportunity was given.

It was impossible on this occasion to deal exhaustively with so large a subject, and he did not propose to enter into a controversy as to whether alternating or direct-current motors were most suitable for foundry work, or at what stage it was advisable to give up the use of compressed air lifts in favour of electric lifts. There were many vexed questions, such as the uses to which electric magnets can be put, also grab buckets for dealing with sand, slag, etc. Given sufficient space, most of these modern appliances could be used to advantage, but if one was working a foundry started 25 to 50 years ago, and which had grown with the business, it was very difficult—in many cases impossible—to use those appliances on an economic basis. On this occasion he would deal with what was actually being done, and done successfully.

Mr. Haigh proceeded to describe in detail the principal features of the arrangements made. All cupola materials entered the works at one point, and were distributed from there. Sand, blacking, gas coal, etc., came in by another road. Coal was unloaded direct on to the stage, and any surplus was put into stock. Blacking was delivered at the mixing shed; the sand went direct to the loam mills or to the sand mixing bay. Generally, all material not required immediately went into stock. Waste sand was removed by tipping wagon (wherever possible) or by barrow, and deposited in bins, where it could be loaded into railway or motor wagons. The waste sand from the tube fettlers was removed by conveyor, and the trucks were loaded simply by opening and closing the valve. The jig cranes in fettling shops had pneumatic hoists or lifts, and were used largely for turning the castings on end for emptying the sand.

Ladle Receiver Advocated.

The branch foundry, with a capacity of 12 tons per day, was used for making small castings, largely snap flask work. In describing this the author gave particular attention to the methods of handling the moulding boxes and the molten metal. He said he did not favour the tapping of metal direct from the cupola into shanks, and it was only permitted in exceptional cases. Metal was tapped into the ladle and poured from there into shanks. He asked the members to note the type of bogie used, and explained that the reason for throwing out of centre was that it allowed the shanks to get closer under the lip of the ladle and facilitated the emptying of the ladle. In distribution the metal was taken as near the man as possible. For the longer boxes the ladle was hoisted from the truck and the moulds poured direct from the ladle. Smaller boxes were poured from a wheeled ladle. Snap flasks were hand shanked.

The main foundry was laid out for the production of upwards of 150 tons of castings per day. In normal times 200 tons of metal were frequently melted in four cupolas. Over each cupola was a jib crane, with electric controller well out of the way. If metal was required for the shanks these were filled from the ladle while it was suspended. Easy hoisting and lowering greatly facilitated the filling of shanks and wheel ladles, and the men could stand comfortably whilst the shanks were being filled. Metal required for heavier work was placed on a bogie with ball bearings, with specially constructed carriage near the ground for safety. One man could move a ton of metal.

Discussion.

Mr. O. Stubbs remarked that Mr. Haigh had given the members so much to think about that the discussion ought to be adjourned to the next meeting. It would be an injustice to so excellent a Paper on so important a subject to attempt to dispose of it at the end of a meeting which had been largely occupied with other matters. The American system of transportation was absolutely overhead, and some information about it would be of interest.

Mr. Haigh suggested that Mr. Stubbs might give the members the results of his own observations of American practice.

Mr. Hogg, in moving a vote of thanks to Mr. Haigh for the Paper, said the figures of the output of the foundries with which the Paper dealt showed the responsibility that devolved upon Mr. Haigh in connection with it, and the amount of experience which gave weight to his statements.

Mr. Masters seconded the vote of thanks. He remarked that in the pictures thrown upon the screen he had observed signs of the master mind which had carried out the work of transforming an old shop into a new one. What was the thickness of the tubes which were turned out of the foundry? There were other members interested in that type of product, and if they knew the thickness they might be surprised.

Mr. Carey Hill said, as a visitor, he wished to support the motion. He had attended meetings of the Midland Branches, as well as the meetings of his own branch at Coventry, but prior to this occasion he had not had the opportunity of attending a branch meeting or lecture in the North. It

was with very great pleasure that he had listened to the Paper. In his own district the foundries were on a smaller scale than tho one which had been described; they dealt with smaller work, and the weight and volume of the materials was very much less. Therefore the problem of transport was less difficult. But one could learn a great deal by listening to the experience of those who worked in other foundries, even though the circumstances were not alike and the practice somewhat different.

Mr. Sydney Smith said it was not an easy task to arrange a good jobbing foundry. The predominating need was that the materials should be handled by the simplest possible methods. Everything that went into the foundry should go in one way, and everything that came out should do so by another way. He would like to have Mr. Haigh's opinion on the question whether the rectangular pit or the circular pit was the better method.

The vote of thanks was passed unanimously.

Iron in Copper and its Alloys.

Dr. F. Johnson, the new Chairman of the Birmingham Local Section of the Institute of Metals, opened the new session with a Paper on "Iron in Copper and Copper Alloys," remarking that, whilst to some manufacturers iron was an extremely undesirable ingredient, to others its presence afforded neither alarm nor pleasure. He went on to say that for the copper refiner iron had few terrors, as it was one of the most readily oxidisable impurities. In an impure black copper a percentage of 3.037 per cent. of iron was brought down to 0.008 in the refined ingot. The tenacity with which iron clung to copper during the smelting stages was succeeded by a feebleness of union during the refining stages.

The toughening influence of iron on arsenical copper doubtless was largely the result of a deoxidising action, as was also the immunity of the ferruginous bars from the embrittlement undergone by ordinary "tough-pitch" copper when heated to a high temperature in a reducing gas.

The alloying of copper with iron was by no means easy, as the rate of interdiffusion was slow and the melting points of the two were widely different. According to Stead, copper could take up 2.73 per cent. iron in solid solution, and iron could take up 10 per cent. copper. Aluminium was very effective in promoting the uniform alloying of iron and copper. An important application of this influence had been discovered in connection with copper-aluminium-iron alloys and the so-called manganese bronzes. Iron did not destroy the machining properties of copper alloys, whilst the addition of iron to copper-aluminium alloys—for example, aluminium-bronze—was beneficial in preventing crystal growth. The importance of iron in reducing the grain size could not be too highly emphasised, for one of the greatest sources of weakness in large castings, such as propellor blades, was a coarsely-crystalline structure. High-strength brasses were now made which would give a yield point of 20 tons per sq. in. and a maximum stress of 40 tons per sq. in., with 20 per cent. elongation from any part of the casting.

There did not appear to be any favourable expert opinion concerning the presence of iron in brass which had to be subjected to corrosive influences. In copper-aluminium alloys iron increased the yield point and tensile strength at the expense of ductility, whilst in gun-metal iron, according to Gulick, raised the tensile strength and lowered the elongation. The author's own experiments with small chill castings showed that iron in the proportion of 0.35 per cent. had a beneficial influence on the mechanical properties, whilst the same remark applied to the influence of 1.0 per cent. iron accompanied by 0.16 per cent. aluminium. The effect of iron alone was to make the alloy sluggish in pouring, but the presence of a small quantity of aluminium restored the fluidity. In Admiralty gunmetal iron did not appear to be detrimental if correctly alloyed, and under such conditions the mechanical properties were improved.

Book Reviews.

"Water Power in the British Empire." By Sir Dugald Clerk, K.B.E., F.R.S., and Prof. A. H. Gibson, D.Sc., M.Inst.C.E. Published by Messrs. Constable & Company, Limited, London Price 3s. 6d.

This work is a collection of the Reports of the Water-Power Committee of the Conjoint Board of Scientific Societies. The importance of water power to the metallurgical trades of Great Britain is not generally realised. Whenever a large source of water power is available in a distant land the exploiters generally examine the possibilities either of smelting iron ore, should this mineral and charcoal be available in the region; or should quantities of scrap be available (as existed in South Africa from the mines and railways), the making of steel on site.

Obviously, it takes some time before sufficient skill is obtained to produce iron or steel adequate for local purposes, but a time is bound to arrive when such Colonial plants will be able to satisfy local demands, to the prejudice of our metallurgical export trade.

The installation of electric steel furnaces during the last decade in South Africa, Australia, Canada, to say nothing of Spain and Italy, must have acted detrimentally to Sheffield's export business, as for every ton of special steel made in these furnaces less is imported, in which business Britain has had the lion's share.

The above, superficially, indicates that it is detrimental to British interests to help in any way the exploitation of Colonial water power. Such, we believe, is a fallacy, as the opening up of a Colonial industry brings trade in other directions. Primarily there is the supply of the original plant, then means of transport, then building materials. With this comes all the diverse material which go to make villages, towns and cities. Whilst some of our Colonies may be in a position to supply the bulk of its own material, nature is so made that no country can be self-supporting. Even the United States lacks rubber, manganese and nickel —three very important commodities. It is thus essential that every engineer and metallurgist should not only be alive to the water-power possibilities and developments in the vast British Empire, but get interested in them from their inception. It is estimated that there exists in the British Empire some 70 millions of continuous potential horse-power, whilst only 15 to 16 millions are as yet developed throughout the world. We do not intend to digress upon the exhaustion of coal and the future of water power, for these subjects, associated with the exhaustion of workable iron ores, the extraction of aluminium from clay, the wireless transportation of electric power in bulk, lead one into the realms of conjecture. Amongst the recommendations made by the Committee, of which the authors are respectively chairman and secretary, are State aid for development where necessary, specialised University training, and an Empire Conference in the near future.

Shop Arithmetic for Machinists, by Erik Oberg. Published by the Machinery Publishing Company, Limited, 51 and 52, Chancery Lane, London, W.C.2. Price 5s. net. Whilst this book is primarily intended for men in machine shops and tool rooms and students in mechanical engineering, there are several sections of distinct use to foundrymen. It is at chapter 7 where they can usefully start, as it outlines the use of formulæ. The chapters which follow deal successively with "Horse Power of Belting," "Time Required for Machining," "Areas of Plane Figures," "Volumes of Solids," and "Specific Gravity and Weights of Bar Stock and Castings." The mensuration portion is one which will help moulders to calculate accurately the weights of castings of a fairly regular form.

Mr. R. E. Higgin, 265, Deansgate, Manchester, and Mr. C. E. Ridley, 35-7, Dundas Mews, Middlesbrough, have been appointed agents for Lancashire, Cheshire, and the West Riding of Yorkshire, and for the North-East Coast, respectively, for Henry Joseph and Company, 96, Victoria Street, London, S.W.1.

An Apprenticeship Course in Foundry Practice.—XVII.

By Ben Shaw and James Edgar.

CORES AND CORE MAKING.

Part II.

Just as the green sand, dry sand and loam moulders have, as a rule, specialised in one particular branch, so the making of cores is now more or less a specialised occupation. In some foundries the core makers are divided into two groups, those who are responsible for the making of cores from oil or other artificially bonded sands and those who make naturally bonded sands; but in general a core maker is expected to be skilled in the preparation of sand mixtures, and to be able to make cores for any class of work necessitating cores, although a distinction is usually maintained between the loam and sand core makers. Frequently the core maker, besides being responsible for the making of cores, is also responsible for inserting them in their moulds, but this refers to complicated work in which a number of cores are involved, and when the coring up or assembling of the mould can be done with greater safety with the aid of the core maker. He is responsible for setting cores in their correct relation to each other and the mould, the final filling in of parts of cores which have been left for access to lifting staples, and in some cases for the testing of thicknesses. The part the core maker plays in the closing of a job varies with its size and intricacy, and to a considerable extent with the customary practice in any one foundry or district.

The degree of skill necessary in the making of cores is not less than that required in the preparation of moulds, and particularly in the making of cores for highly complicated work; the difficulty is not so much the preparation of the mould, but the making and assembling of the cores. It must be remembered that many cores are required to be almost wholly surrounded with metal, and however much care is necessary in the formation of the moulds in which they are to be made, greater care is usually necessary when making the cores. This is essential not only to provide a surface which will produce a skin on the interior of a casting comparable with that on the outside, but also in order that they will vent freely and be easily removed from the casting. They must be sufficiently strong to be handled and to resist the liquid pressure of the metal and at the same time sufficiently weak to offer but slight resistance to the casting during the critical time of contraction.

Coremaking Machines.

Making cores by mechanical means is not so well emphasised as machine moulding, but there is ample room for its use in many foundries. The making of cores does not differ essentially from the making of moulds. The fact that the former gives an internal impression, whereas the latter is concerned more or less with external shapes, does not debar the use of mechanical means for making cores any more than for moulds. Many of the moulding machines can be readily converted into coremaking machines and become equally as profitable when used for that purpose. Probably the most common form of coremaking machine is that used for parallel cores of any sectional shape. There are two types of machines that are employed for this purpose, the rotary or conveyor and the plunger. The former (Fig. 1) is used solely for parallel cores, and although any sectional shapes can be made according to the dies used, they are usually circular, other sectional shapes not being used to the same extent as round cores. This type of machine works on the same prineiple as the ordinary mincing or sausage machine, sand being fed into the hopper to a worm or conveyor, which, on being rotated, forces the sand through a die and produces a core corresponding in sectional shape to the die through which it passes. The conveyor may either be operated by hand or by mechanical power, and cores ranging in diameter from $\frac{3}{4}$ in. to 7 in. are readily produced up to about 2 ft. 6 in. long. Special core plates are used to support the cores as they come through the die and upon which they are dried. An oil sand is usually used on this kind of machine, although flour may be added to give greater green strength to the core and so reduce the possibility of it collapsing as it is being pushed along the plate. Vents are formed in the cores as they pass the dies, and they vary according to the diameter of the cores. The plunger type of machine (Fig. 2) is not confined to the making of parallel cores, but it can be used for shaped cores which can be stripped from their dies or coreboxes in a vertical direction. This, however, necessitates loose pieces in the dies and makes their construction more involved ex-

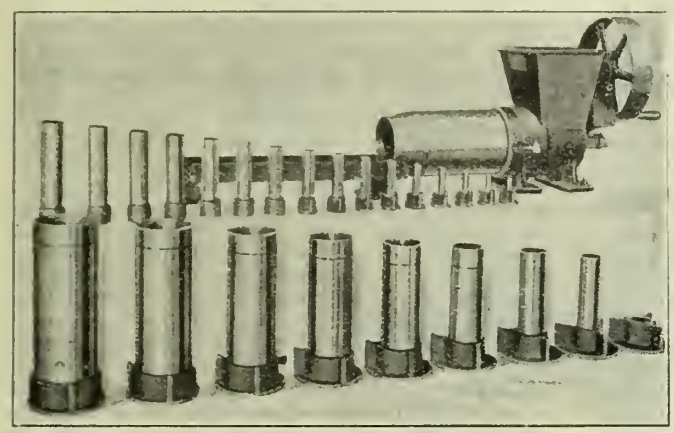


Fig. 1.—Wadsworth Core Machine.

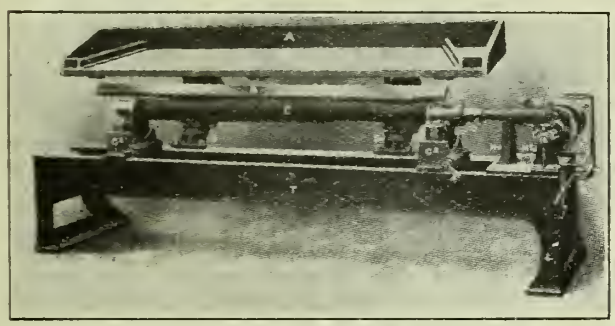


Fig. 3.—Pipe-core Machine.

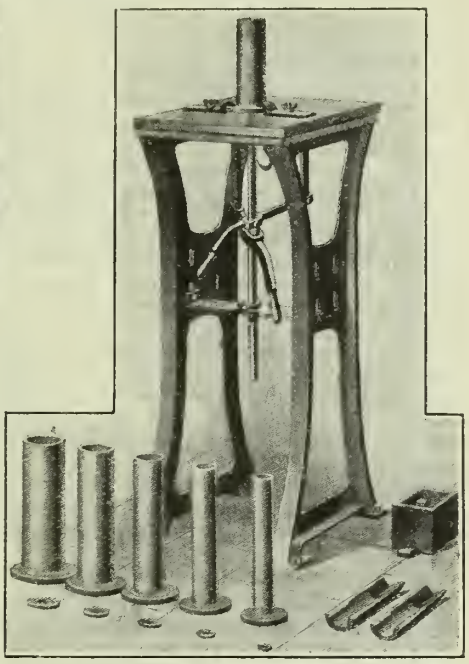


Fig. 2.—Plunger-type Core Machine.

cepting for the simplest of irregular shaped cores. In this type of machine the die is fixed to a table and over a plunger of the same sectional shape as the bottom of the die. Sand is rammed in the die by hand and then vented when the core is stripped by means of the plunger. The plunger may be operated by a direct lever arrangement or by rack and pinion according to the type of machine used, and the sizes of cores vary from ¾ in. to 6 in. dia. and any length up to 9 in. Oil-bonded core-sands are not so suitable for cores produced on this machine, unless they have other bonds in their composition which increase the green strength of the sand, because they must be handled when they have been stripped from the die or core-box.

Another core-making machine especially designed for preparing pipe cores prepares the cores on a spindle or core barrel (Fig. 3). Ordinary moulding sand is rammed against the core barrel by means of a reciprocating steel bar as it revolves. Either green or dry sand mixtures may be used, according to the class of work for which the core is required. The machine is operated by mechanical power, which rotates the core barrel and operates the steel bar, but the sand is fed by hand. It has a wide range, being readily adjusted for any cylindrical cores varying from 2 in. to 21 in. dia. and any length between 9 in. and 9 ft. Larger machines are necessary to cope with larger cores. Probably the most useful machine which can be used for general purposes is the core-jarring machine. Any sized core-box may be used up to the capacity of the machine. The smaller types are usually set into the core benches with the operating table about the same height as the bench, but otherwise clear of it, so that the vibration will not affect the rigidity of the bench. The core-boxes are usually filled with the core-mixture by hand, which is then jar-rammed and the whole transferred to a plate for stripping preparatory to baking. Any core-mixtures may be used according to the special needs of the work. The only advantage of this type of machine is that it obviates hand ramming, excepting when the sand needs to be tucked into internal pockets, but it produces a core of more regular density without the hard and soft places common to the hand-rammed core, and it expedites their production. The larger types are used for large dry sand cores, many of which would otherwise be prepared in loam, and, as full core-boxes are necessary, in some instances they can only be profitably used when the number of cores required warrants the construction of a full core-box. The hand or power press machine is also used in the making of cores, and invariably some turnover device is used in conjunction with it to facilitate their production.

Cores for Repetition Work.

When quantities of similar cores are required for repetition work, such as small valves, pipe fittings, etc., a number of cores are usually prepared at one operation from a multiple core-box, which carries the impressions for many half-cores, the number depending upon their size. These multiple core-boxes may be composed of some composition, such as is used for match-plates, or they may be cast in metal. Cast-iron is sometimes used for this purpose. They may be prepared in halves, with suitable guide-pins for use on a press machine, or the one plate may be used on a jar-ramming machine to produce half-cores, which are afterwards pasted together. An illustration of such a multiple core-box is shown in Fig. 4. When an oil-bonded sand is used, the cores need to rest flat on a plate or be supported until they are baked. It is, therefore, convenient to prepare them in halves, venting before they are stripped, so that they can rest flat on a plate, but in order to save time in pasting, the complete cores may be made and supported on shaped plates for baking. Such cores need no rodding, and they shake out readily after the castings have been made. Although oil-sand cores are very weak when green, they are very strong and easily handled after being dried, and as long as the cores are sufficiently small to be handled without the aid of cranes, rodding or the use of grids is almost eliminated. Projecting parts of comparatively small sectional area may be wired or brads may be used, and these are generally sufficient, after which the cores may be inserted in their moulds either directly by hand or suspended on tapes or string; but when the crane is used and it is not possible to use a fibre or leather sling about the core, some form of stiffening is necessary to provide staples for lifting and in order to support the core so that its weight is distributed. Generally when the cores are large and not capable of being handled it is customary to make use of naturally bonded core mixtures, not because these are necessarily better for such cores, but because they are relatively cheaper than artificially-bonded core mixtures, and the economical production of castings must not be overlooked. In some instances artificial binders are used to give additional strength to weak naturally bonded sands, but as the size of the cores increase, the economic value of special core-binders decreases; thus, except in special instances, naturally bonded core mixtures fulfil the average requirements for large and medium-sized cores.

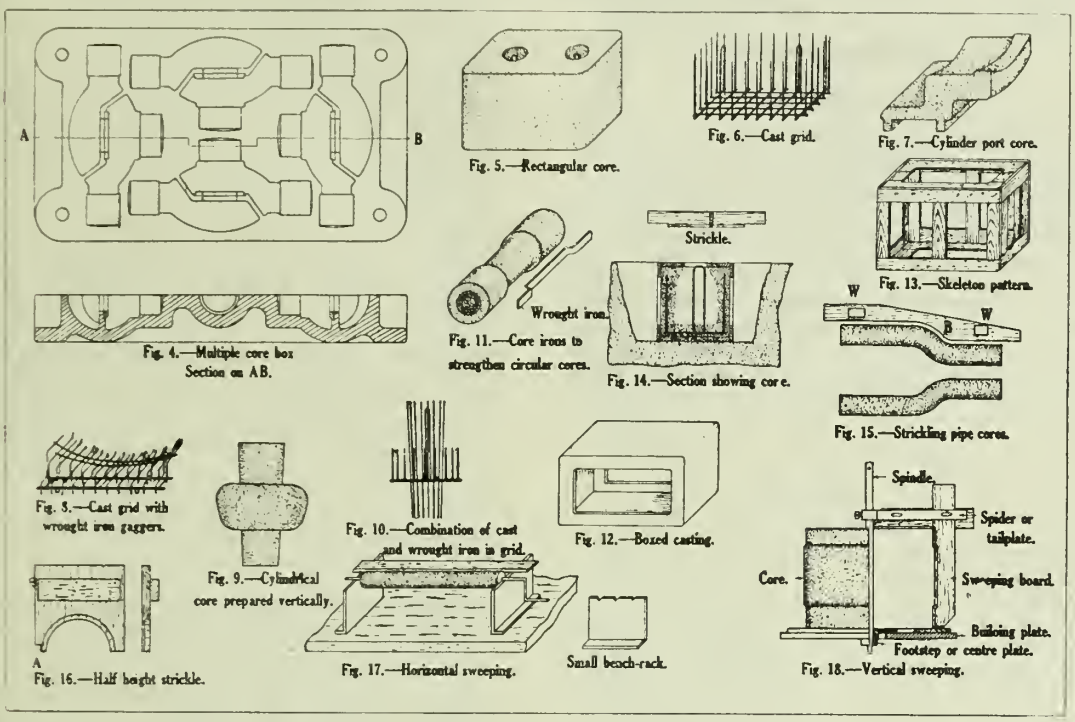
Core Grids.

With such cores some form of rodding or grids is necessary, but whatever the form of support to enable the core to be lifted, consideration must be given to the ease by which it can be removed from the finished casting. This is important when the area of the outlet, through which the core irons or grids must be extracted, is small. It is frequently necessary to use wrought iron in preference to cast iron, the ends of which are so arranged in the core that they are accessible near the outlet for drawing from the casting; then, however much they may follow the irregular shape of the core, they can easily be withdrawn. When cast iron support is given to a core which will leave comparatively small area for its removal the grid must be broken, and this fact must be considered when the grid is being made, otherwise much additional labour may be incurred in fettling the casting. Wrought iron is frequently cast into grids, or the cast iron may be only a minor part, and used for securing the pieces of wrought iron. Their use is very helpful when cleaning the casting, particularly when the cast part is easy of access for breaking. There is, however, another advantage which is not always considered, wrought iron is less rigid than cast iron, and it therefore offers less resistance to the core crushing during the time the metal is contracting. When there is ample room for the removal of the core the grid is made of cast iron, it being more easily made. Thus the simple rectangular core shown in Fig. 5 would need a grid such as is illustrated in Fig 6, whereas the grid for a cylinder steam core, such as is shown in Fig. 7, would be more easily made and have greater value if pieces of wrought iron are cast in a bar similar to Fig. 8, instead of attempting to make the grid wholly of cast iron. A grid composed of cast and wrought iron is also of value when the cast iron part is used near the centre of a core, and the sand above and below it needs support. Gaggers or prods can, of course, be formed on one side of the grid, and pieces of wrought iron cast in for the other. The core may be enlarged about the centre as in Fig. 9, and the cast iron part of the grid can be formed to strengthen the enlarged portion, whereas wrought iron cast in it, as shown in Fig. 10, will support the remaining parts of the core. Then with such cores as water jacket cores, that need some support for lifting purposes as well as to give strength, the inlet and outlet are, as a rule, so small that cast iron grids of any kind are out of the question. In such instances a wrought iron grid should be built and the parts wired together in order that the pieces can easily be separated and drawn out after the casting has been made. Shaped pieces of wrought iron are frequently used for strengthening a swept core when the spindle upon which it is swept is removed after the core has been dried. An illustration of this form of strengthening is shown in Fig. 11. A number of shaped pieces of flat iron are set into the core and wired into position before the final coating is applied to the core. It is necessary to exercise care in the making of grids, because they should offer as little resistance as possible to the core crushing under the strain of the metal when it is contracting.

Loam Core Making.

Although dry sand mixtures, whether naturally or artificially bonded, are commonly used for

smaller cores, and to a considerable extent for medium-sized cores, core loam is more frequently employed for large cores. In many foundries the use of sand for cores is limited to the smallest of cores, the remainder consisting of core loam. Much depends upon the material supplied from the patternshop from which cores are to be made as well as the common practice of the particular foundry. More patternwork is needed when core sands are to be used than when core loam is used. The sand needs to be rammed, and a substantial surface is necessary against which it can be rammed, whereas core loam does not need to be rammed, and skeleton or framed core boxes may be used. As a matter of fact, such boxes are better for loam cores because core loam is used wet, and it is advisable to reduce the amount of timber in contact with it as much as possible to prevent the wood varying in form, due to the absorption of moisture, from seriously affecting the size of the core. It is this form of core making material which is particularly suitable for making the core or cores in a skeleton shell pattern. A simple illustration of work of this character is shown in the boxed casting illustrated in Fig. 12. It is not necessary to make a block pattern and core-box, particularly if only one or two castings are required; the skeleton shell pattern, Fig. 13, fulfils the purpose adequately. The method usually adopted is to prepare a hole in the sand floor and set the pattern in on a level bearance with the top of the pattern about flush with the floor surface. In this position the moulder can proceed to make the core. Parting sand is applied to the bearance and a covering of core loam given, and into this is bedded a clay washed grid and more core loam applied, so that it follows the inside shape of the pattern and about 4 in. thick. Dried loam may be introduced in pieces here and there to stiffen the soft core loam more rapidly. The loam should, of course, bind round the gaggers on the grid, but the centre of the core may be left hollow until it is dried and returned to the mould, when sand may be lightly rammed in. When the pattern has been filled in this way and the core loam has been allowed to stiffen, a strickle checked back a thickness equal to that of the sizes of the pattern, is used to remove surplus loam from the sides in the manner shown in the section, Fig. 14. When this has been done and the surfaces sleeked, the remaining part of the work is done in sand. The complete outside shape of the pattern is made up with sand in the first place, after which the mould can be prepared.



Strickling and Sweeping Core Loam.

Besides being profitably employed for cores when full or skeleton core-boxes are supplied, core loam owes much of its value to the fact that it can be strickled or swept by means of strickles or sweeping boards having a profiled edge similar to the external shape of the core needed. Thus, the core for a pipe, required to connect two lines of piping that are not in a direct line with each other, may be made by means of a strickle and guide bar. Such a core would be made in halves on a flat bearance in the manner indicated by Fig. 15. The strickle, Fig. 16, is shown as a half-height board. It consists of a board about 1 in. or 1⅛ in. thick, having a semi-circular opening cut out equal in size to half the required core, and having one leg A cut to a definite size to suit the guide B (Fig. 16). That part of the strickle which is used to form the shape of the half-core is chamfered in the manner shown, leaving the profiled edge about ¼ in. thick. This is done in order to apply pressure on the loam and towards the core in formation as the strickle is being moved along. The process of making each half-core with such a strickle consists in first weighting the guide-bar, which may be in wood or iron, and then trying the strickle along it to locate the approximate centre of the proposed core. About this centre sharp or sea sand may be used if the core is to be more than about 6 in. diameter for venting. This obviates the necessity of cutting out the vent after the core has been dried. A bedding of core loam is spread over the bearance to the approximate joint shape of the core, and into this is bedded a grid or core iron; more loam is then applied and it is given the requisite shape by working the strickle in contact with the grid. Large half-cores are generally allowed to stand before they receive the final coating of loam, for which purpose it is thinned with water. Dried loam may be introduced into the core loam during the process of making the core, and this hastens the stiffening and at the same time reduces the possibility of the core sagging before it is dried. Usually some slight allowance for sagging is necessary when making the strickle, from 1-16 in. to ⅛ in. being made according to the size of the core. The guide must be reversed for the other half core. When the two parts are dried they can be wired or bolted together, according to their size, clay wash being applied to the joints before they are secured.

Strickles of varying shapes can also be used in conjunction with framed boxes for use with core loam, that would otherwise need to be full core-boxes if a dry sand mixture is intended to be used for the core, and reference will be made to those when core-box construction is under consideration.

Many cylindrical cores are made in loam, and the patternwork involved in their production is limited to profiled edged sweeping boards. When the cores are long in comparison with their diameter,

they are prepared on a spindle or core barrel which is rotated. The profiled edged board is located at a definite distance from the centre of the spindle determined by the diameter of the core required; this dotermines the amount of loam the spindle must carry and also the shape the core is desired to have. When the cores are large in diameter compared with their length, it is usually better to prepare them vertically. By this method the sweeping board is rotated, the core remaining stationary. For rotating the board a machined spindle is used, which revolves in a special footstep or centre, which, in many cases, ongages the spindle sufficiently to maintain it in a vertical position when being rotated. To the spindle is secured a spider or tail piece to which the sweeping board can be fastened. In this way the board can be set at a definite distance from the centre of the spindle—by means of a gauge stick—and tho core built on a prepared bearance, the board being rotated with the spindle to sweep the loam to the contour that it represents. The illustrations, Figs. 17 and 18, show the methods and the tackle usually employed in preparing cores about a horizontal and vertical spindle respectively. The making of large cores of this nature comes properly under the general heading of loam moulding, and consequently we propose dealing with sweeping work more fully when we deal with loam moulding.

Inventions.

In opening his Address before the Institution of Mechanical Engineers on Friday, October 20, Emeritus Prof. H. S. Hele-Shaw, LL.D., D.Sc., F.R.S. (President), remarked that the year 1922 was the seventh-fifth anniversary of the foundation of the Institution of Mechanical Engineers. The kindred engineering societies in Belgium and Holland had celebrated their seventy-fifth anniversaries this year. Reviewing some of the recent outstanding features of the Institution's advance, and discussing the subject of engineering education, the President remarked that ten years ago an important step was taken by the Institution in the inauguration of their own examinations. These were instituted to ensure that those who could not produce satisfactory credentials from colleges and schools of engineering should give evidence that they had acquired knowledge of those principles of engineering science on which sound practice rests.

After some remarks on the general activities of the Institution, the President went on to discuss the question of scientific knowledge and invention, asserting that all progress, at any rate in mechanical science, must be in the nature of invention. Every fresh step taken, in which new ground was trodden, every new device or new mechanism or new machine of changed form, in which movement of parts differed or even if the object attained was different, could only result from the exercise of the inventive faculty. Even where it was necessary to duplicate indefinitely any existing machine or machine part, invention was required, and had in recent years been exercised in a wonderful way for production purposes. Here, again, if the manufacturing engineer was to hold his own in competition, new ground must be broken all the time. But this was exercising the same faculty as required for devising new designs, either of the complete machine or of the separate parts.

On the subject of futile inventions, the President remarked that engineers in practice, in the course of their work, constantly spent large sums of money on inventions which, if thoy were more plausiblo, were not less impossible than some extreme cases mentioned by the speaker. In ninety-nine cases out of a hundred a sound training in principles of physical and mechanical science would keep a man on sound lines and enable him to use that power which most of all distinguished him from a mero animal, namely, imagination. He had long thought that, beyond general engineering training, the time had come for an actual Chair of Invention, and still hoped to see such a Chair foundod somowhere. Continuing, the President said that whatever impulse in the way he had suggested, or in any other way, the Institution might be able to give to invention, it must not be overlooked that by far the greatest inducement to invent was the protection afforded by the Patent Office. A patent was granted, not as some people thought because the Government had the slightest interest in that individual inventor, but simply and solely in the interests of the public, so that by the inducement of the reward in the form of a monopoly for a certain number of years the public might in return reap tho fruit both of the genius of an inventor and of the expenditure of money by the capitalist necessary to produce and bring to fruition a successful invention.

There were certain matters in which their Institution might use its influence, suggested to the President by a friend of experience. One of these concerned the revocation of a patent, another designed to effect a clear understanding of the relation between employer and employee in matters of invention, another the rights of the Controller of Patents in regard to the power of refusing a patent for something which, although it might be new, was not, in his opinion, an actual invention, and, lastly, the introduction of something sorely needed between a patent and a design as provided for by German Patent Law. Taking these briefly in order, he would say that, while a patent could be opposed on the grounds that the invention had been made public by some publication or other, one could not oppose it on the ground that the invention had actually been made and sold. It ought to be possible, by proving to the Controller himself that such an invention had been actually made and sold, to give him the power to revoke a patent, or to oppose its being granted, whereas at present the only way of doing this was through the expensive proceedings of a High Court.

The second matter, namely, the relative rights of employer and employee, was a difficult one. It was usually met by some form of agreement which the employees were asked to sign. This was not fair to an employee. Under such an agreement an employee might make a valuable invention to which he then had no claim whatever. On the other hand, without such agreement, the employer might be providing all the money and paying the time of his draughtsman, who might proceed to take out a patent himself for what he had arrived at whilst he had been paid by his employer to do that very work, and whose ideas he might have incorporated in his patent. It should be quite simple to have an equitable arrangement by which there must be some sort of Court of Appeal which could adjust the proper shares in rights to each party in such cases.

Turning to the third matter, in Section 93 the Patent Office had power to refuse a patent on the grounds that it was not a new manufacture. At the present time, continued the President, this clause was being interpreted to mean that the Controller could refuse a patent on the ground that the subject matter, while new, was not an actual invention, or, as the Patent Law would put it, " not good subject matter." Now the question of subject matter being adequate or not should go through the Courts, with a final appeal to the House of Lords, but in the above Clause 93 the appeal was to a law officer who was Solicitor-General, and his decision was final.

To-day, when there was so little opportunity in mechanical engineering directions of far-reaching discovery, and consequently of a master patent, a cheaper patent for a short time (say a period of five or six years), ought to be granted for an improvement which might be of great value, although the matter might be a comparatively small one. For this a small fee might be charged (say £1 a year), enabling the inventor to introduce small improvements for which he would not receive adequate protection by registration of design, but which would be at once copied. Thus, after great expense in the way of experimenting, devising, and making patterns, he found a week or two afterwards that his actual device had been copiod, oven put on the market, even perhaps been actually used with a trivial alteration as a pattern to mould from. Engineers would appreciate the discouragement to progress which the absence of protection produced in cases of this kind.

The Metropolitan Vickers Electrical Company, Limited, have opened their new showrooms situated in Chapel Walk, Sheffield.

Trade Talk.

The Electrical Alloy Company has removed from 4, Regent Square, to 281, Gray's Inn Road, W.C.1.

Hall & Pickles, Limited, Port Street, Manchester, are opening a new office at Oxford Offices, Oxford Row, Leeds.

A furnace is being put into blast at the works of the Barrow Hematite Steel Company, Limited, making a total of three blowing.

Vickers, Limited, Barrow, have received an order for a set of Diesel internal combustion engines for a coasting vessel for Japan.

The imports of foreign iron ore into Maryport last week amounted to 3,500 tons. This was the first consignment that arrived during October.

The Adamant Engineering Company, Limited, have erected extensive new works at Dallow Road, Luton, which are now completed and installed.

Bolton's Superheater & Pipe Works, Limited, have removed their office and works from Trafford Park, Manchester, to Adswood, Stockport.

The Spearing Boiler Company, Limited, have secured the contract for two water-tube boilers of 30,000 lbs. each from the Watford Corporation.

Mr. George Walter, coal, iron and steel agent, etc., has removed from 49, Leadenhall Street, London, E.C.3. to 10, Great St. Helen's, London, E.C.3.

The imports of foreign iron ore at the Lonsdale dock at Workington last week amounted to 1,350 tons. Outward consignments included 1,100 tons of rails.

The offer for subscription of £1,000,000 5 per cent. debenture stock of Pease and Partners, Limited, was made on Thursday. The stock was issued at 93 per cent.

Hogan Bros. and Company, 44, South William Street, Dublin, have been appointed agents in the Irish Free State for the Holland Insulated Wire and Cable Works, Amsterdam.

Mr. J. P. Scarratt, of 6, Hunter Street, Liverpool, has been appointed agent in North Wales for Johnston & Young, iron and tinplate merchants, 4, Queen Street, Old Hall Street, Liverpool.

Fry's Metal Foundry, of 25-42, Holland Street, Blackfriars, London, S.E.1, have acquired the business of the Light Casting & Patternmaking Company, Limited, Hillside Foundry, Kingsbury Road, Kingsbury, N.W.9.

The improvement in trade enabled the Conciliation Board meeting in Nottingham, on October 26, to increase the rates of pay of blast furnacemen and ironstone quarrymen in the Midland area by 1¼ per cent. on the percentage over base rates.

Princeps and Company, engineers, who recently removed their head office from Matilda Street to 14 and 17, Wentworth Chambers, Pinstone Street, Sheffield, have re-appointed Mr. T. T. D. Geesin, of 4, Clevedon Road, Penge, S.E.20, as their London representative.

Messrs. G. Curtis Holt & Company, Limited, who specialise in air compressors, receivers, moulding machines, and cupola blowers, have opened a branch at 5, Blackfriars Street, Manchester. Their headquarters still remain at 2, Basinghall Street, Leeds.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Anglo-Russian Black Sea Development Company, Limited, 20, North John Street, Liverpool; Jackson & Walker, 86, Two Trees Lane, Denton, near Manchester; and the Ynis Bronze Company, Limited, 69, Leadenhall Street, London, E.C.

The Sheffield Rolling, Forging, and Tilting Technical Society held its second meeting in the Mappin Hall on October 27. Professor Desch, who was to have given an address on "The Scientific Equipment of Steel Works," was unable to be present owing to indisposition, but Dr. Longmuir contributed a paper on "The Reading of a Specification." Mr. Slater Willis presided.

The Victoria Brass Foundry Company, Limited, Bonnington Road, Leith, Edinburgh, have placed an order with Ritchie, Hart & Company, Limited, of the Mountpottinger Foundry, Belfast, for a core-making machine, to deal with stern tube liner cores, of 30 in. dia. and 25 ft. long, whilst Babcock & Wilcox, Limited, have ordered a foundry floor dressing machine from the same firm for their Renfrew works.

The opening meeting of the session in connection with the Staffordshire Iron and Steel Institute was held at the Education Offices, Dudley, on October 28, when the following were elected members:—Messrs. A Madeley, manager of nut works J. Chadwick, forge manager, and T. Hoskison, manager at the Earl of Dudley's Level New Furnaces. The president, Mr. Jos. Payton, in his address, reviewed the industrial situation. Subsequently an address was given by Mr. F. J. Cook on his American experiences in connection with the iron and steel industries.

Company News.

Allufix Metal Company, Limited.—Capital £5,000 in £1 shares. Directors: Col. W. H. Briggs, J. G. Crossman, and J. Kilby.

Arjayco, Limited.—Capital £100 in 1s. shares. Ironfounders. Directors: G. M. C. Hart-Smith and C. C. Raven.

Boston Engineering Company, Limited.—Capital £3,000 in £1 shares. Directors: F. Hopper, E. Brotherton and J. Oldridge.

Charles D. Phillips, Limited, Emlyn Engineering Works, Emlyn Street, Newport, Mon.—Capital £75,500 in 75,000 ordinary shares of £1 and 2,000 employés' shares of 5s. Engineers

Effingham Engineering Company, Limited, Parliament Mansions, Victoria Street, London, S.W.1.—Capital £1,000 in 1s. shares. Directors: C. Pillow and C. A. H. Wood.

Frank Cryer, Limited, Jessop Street, Castleford.—Capital £5,000 in £1 shares. Engineers and ironfounders. Directors: F. Cryer, Florence M. Cryer, A. Gregory and G. Gregory.

J. & S. Leaver, Limited, 16, Eanam, Blackburn.—Capital £4,000. Mechanical engineers, machinists, etc. Directors: S. R. H. Leaver and N. Leaver (secretary).

K.B. Patents, Limited, 78, Petty France, Westminster, London, S.W.1.—Capital £500 in £1 shares. Ironfounders, mechanical engineers, etc. Directors: R. W. H. Kane and F. Badcock (both permanent).

Mantle, Sons & Company, Limited, Bayford House, Upchurch, Sittingbourne, Kent.—Capital £2,500 in £10 shares. Founders, engineers, etc. Directors: A. W. Mantle (managing director) and J. H. S. Mantle.

Midland Manufacturing Company, Limited, Celtic Works, Savile Street, Sheffield.—Capital £10,000. Mechanical engineers. Director: Mr. T. J. Fryer.

Regent Sheet Metal Machine Tool Company, Limited.—Capital £15,000 in £1 shares, to acquire the business carried on by Regent Shears (1918), Limited, at Wakefield. Directors: T. Black, L. N. Ledingham, and W. M. Black.

Rowe, Hyde & Company, Limited.—Capital £800. Engineers, etc. Directors: D. S. Rowe, H. A. Hyde and L. W. Gomer.

Renold Chains, Limited, Burnage Works, Burnage Lane, Didsbury, Manchester.—Capital £10,000. Directors: Hans Renold, C. G. Renold, W. H. Jackson and H. G. Jenkins.

Gazette.

Westwood Engineering Company (Wigan), Limited, are being wound up voluntarily, with Mr. G. H. Turner, Arcade Chambers, Wigan, liquidator.

Messrs. W. Sadler, J. Wager and L. Seddon, electrical and mechanical engineers, 276a, Buxton Road, Stockport, trading under the style of the Stockport Electrical and Mechanical Engineering Company, have dissolved partnership.

The partnership heretofore existing between Messrs. R. Stewart and J. Drummond, electrical engineers, 23, Grange Road, Darlington, under the style of the Tyne & Tees Electrical Company, has been dissolved. Mr. J. Drummond continues.

Messrs. H. Crossley, R. Leach and B. Overfield, brass founders, finishers and engineers, Cowhill Brass Works, Oldham, trading under the style of Crossley & Company, have dissolved partnership. Mr. H. Crossley and Mr. R. Leach will continue.

Messrs. V. F. P. Thompson and S. D. Morgan, carrying on business at 45, Horseferry Road, Westminster, London, S.W.1, under the style of the Standard Concrete Machine Company, have dissolved partnership. Mr. Thompson continues the business.

A petition for the compulsory liquidation of the Sheffield Steel Products, Limited, was before Mr. Justice Lawrence in the Companies Winding-Up Court on October 31. Counsel for the petitioning creditors said that the assets of the Steel Products Company were under the control of Sir William Peat, of Messrs. W. B. Peat & Company, chartered accountants, as receiver for the holders of the debentures, of which there were two issues, amounting to more than a million. It was hoped that a scheme of reconstruction could be brought about, and he suggested an adjournment until next sittings. His lordship adjourned the petition as suggested.

Mr. J. B. Tompkin, governing director of Flockton, Tompkin & Company, Limited, Newhall Steel Works, Sheffield, who died on August 5 last, left estate of the gross value of £112,489, with net personalty £109,585.

IRON AND STEEL MARKETS.

Pig-iron.

In reviewing the present position of the pig-iron industry, perhaps the most reassuring feature of the conditions is a slight increase in the volume of home demand, which, although still confined within the limits of immediate requirements gives indications of an ultimate return to a normal average consumption. Recently, of course, smelters have been largely dependent upon exports for an outlet for their production, and while the Transatlantic demand continued had little difficulty in disposing of the furnace outputs with the additional advantage of disposing of the heavy stocks of iron accumulated during the slump period. Some idea of the extent of the relief thus provided is afforded by the returns of shipments of iron from Tees-side ports in October, the total to the United States amounting to 28,628 tons out of 66,381 tons, the shipments to American ports in September having accounted for 31,119 tons. Shipments to Germany dropped from 8,460 tons to 1,030 tons, a result, no doubt, of the collapse of the exchange. Italy was up from 2,205 tons to 3,054 tons, and other substantial buyers were:—Belgium, 3,826 tons, a slight decrease; Finland, 1,685 tons; France, 1,295 tons; and Sweden, 1,928 tons. In the Midlands furnace production is still on a limited scale, but at Birmingham market last week signs of returning activity were distinctly perceptible, although progress in that direction is still hampered by the high prices of fuel, coke prices having been advanced quite 3s. per ton, equalling a sum of quite 4s. 6d. per ton extra in the production of a ton of pig-iron. In the Glasgow iron market the cessation of American buying has resulted in a small decline of values for Scottish pig, and business consequently is quiet. Imports of Continental iron to Clydeside are also on the increase, and the low prices quoted are adverse to the interests of the home producer. On the North-East Coast business is again on a restricted scale, the uncertainty of the political position doubtless influencing conditions to some extent, while American buyers are now adopting a more cautious attitude. At present transactions on United States account are principally confined to orders for foundry iron to special analysis, with low phosphorus content, makers of these qualities being well booked over the remainder of the year. On the whole it may be said that a more optimistic view of the trade prospect is taken by Cleveland ironmasters, a partial resumption of American buying being anticipated, while a satisfactory increase in home inquiries has apparently justified the restarting of additional local furnaces by Pease & Partners, Limited, and the Lackenby Works. Current quotations are firmly maintained as follow:—No. 1 and silicious, 97s. 6d.: No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s.

The East Coast hematite market maintains its strength, with a steadily improving home demand. For East Coast mixed numbers 93s. is now demanded, though here and there this could be shaded for reasonable quantities. The premium for No. 1 is unchanged at 6d. to 1s. per ton. In the export trade there is a good deal of inquiry from the Continent, but it is not surprising that at the moment it leads to very little business. Trade with Italy has been interrupted by the Fascisti trouble, and Germany just now is right out of the market, though Belgium continues to buy moderate quantities.

Finished Iron.

Improvement in demand for finished material, although admittedly progressive, continues lamentably slow, and in the South Staffordshire market business is still restricted in scale, with inquiries, however, in slightly better volume. Reports of substantial wagon orders having come to this district, however, encourages the hope that the period of severe restriction and stagnation is gradually being left behind. In most respects, however, the industry is scarcely less disorganised and irregular than it has been for so long. There is still very keen foreign competition in some lines, while spasmodic incursions by home makers in other districts occasionally upset market prices in a most discouraging way. Another depressing effect is that the prices obtainable under the best possible circumstances are barely remunerative. Manufacturing costs are still far too heavy in relation to the selling prices which are possible in this market, and while fuel remains so dear there is little hope of relief. Makers of bar iron of marked qualities are still more fortunately placed than other members of the trade producing the commoner brands, the latter being subject to considerable foreign competition from French, Belgian and German producers. Prices are consequently irregular, makers being often compelled to accept orders at lower rates to keep plants running, very often at substantial pecuniary sacrifice. The shipments of manufactured iron and steel during October amounted to 38,593 tons, as compared with 26,677 tons in September, an increase of 11,921 tons. India and Ceylon took 13,947 tons, as against 8,060 tons, and 3,056 tons went to Portuguese West Africa. Australia received 4,108 tons, against 2,693 tons, and Japan 2,199 tons, against 1,497 tons.

Scrap.

A rather better feeling may be noted in some sections of the scrap metal trade, chiefly confined as previously to that for heavy steel material for which an increasing demand is in evidence. Accepting the Tees-side market as representative of the general tendency in the scrap trade, reports from that district indicate a steadily growing inquiry for heavy steel, the price of which is strong but unchanged at a minimum of 68s. per ton. Heavy steel turnings are also an active market, with the price firm at 54s. There is a little doing in c.i. borings at 52s. 6d., and there are indications of improvement in heavy machinery quality cast-iron scrap, which is obtainable at about 75s. to 77s. 6d. per ton. Ordinary descriptions are quoted at about 70s. to 72s. 6d. There is no effective demand for heavy wrought iron, and prices are nominal at 55s. to 57s. 6d. for bushelling, 60s. for ordinary heavy piling, and 70s. to 75s. for specially selected heavy forge. All prices are delivered works.

Steel.

Conditions in the various steel-making centres are again reported quiet, but there are certainly more inquiries in evidence, although individually limited in quantity, yet amounting in the aggregate to a fairly substantial tonnage. At present there is very little doing in acid billets, but basic billets are selling with some freedom. There is also an active demand for

(*Continued on page* 396.)

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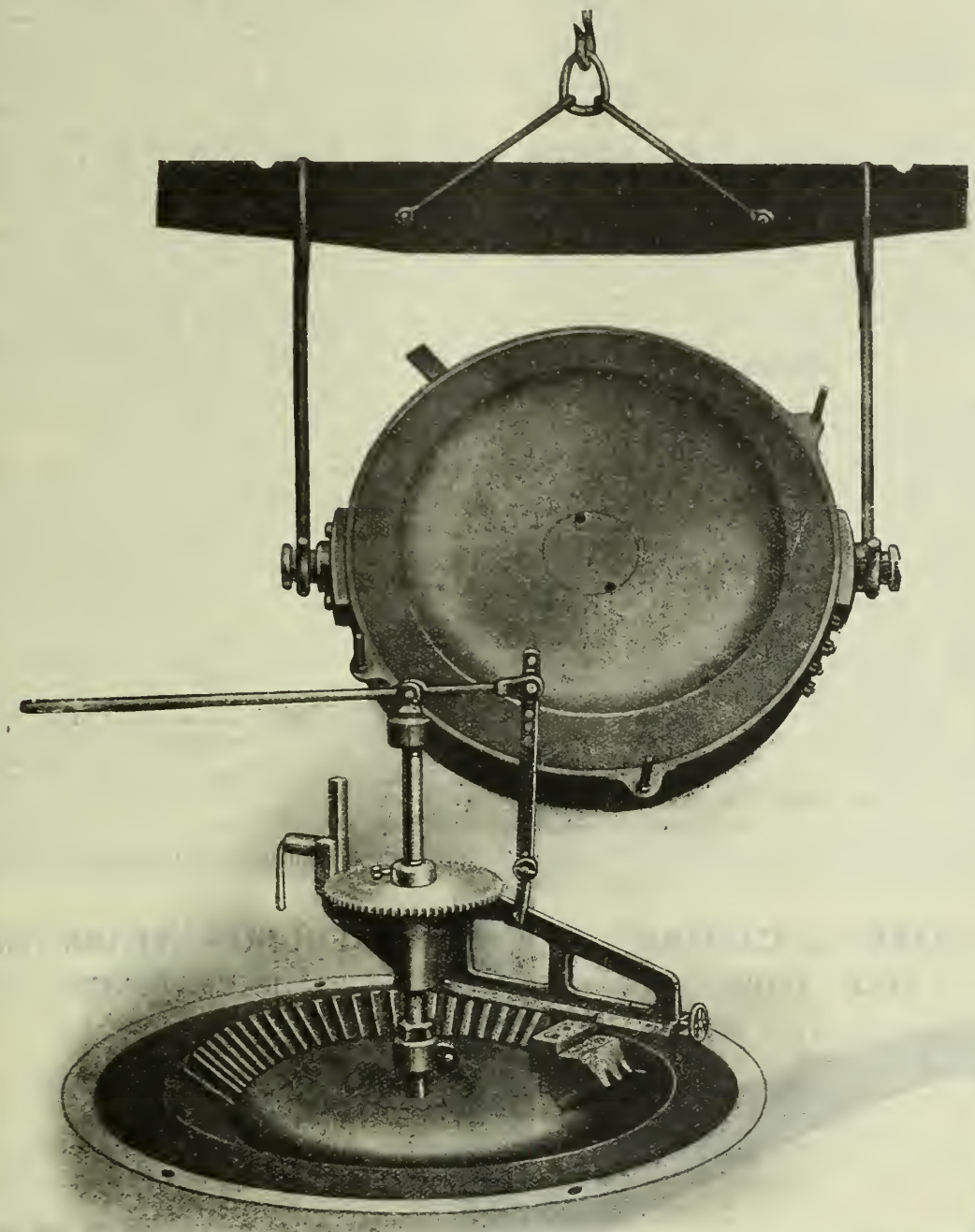
The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

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BLACKFRIARS, MANCHESTER.

basic steel of the cheaper kinds, and more furnaces are now in operation than for months past on this material. With reference to high-grade steel, however, conditions are different, for little more than a fourth of the furnaces in the Sheffield district devoted to its production are employed at the present time, and so far as can be judged the position is not likely to improve just yet. The home demand for ferro-manganese remains fairly good, but the present output appears sufficiently large to cover probable requirements for some time. The price of 76 to 80 per cent. material is unchanged at £15 for the home trade and £14 10s. for export. In the United States sales have been for a few small lots, on which the usual price of $67.50 c.i.f. tidewater was done. This figure is equivalent to $101.10 duty paid at tidewater for 80 per cent. metal. Dealings in the tinplate market of late have been fairly active, the business passing having been transacted on the minimum fixed price of 19s. 6d. per box and upwards for IC 14 by 20, 112 sheets, 108 lbs. in coke finish, net cash, f.o.b. Wales. The rise in tin is, of course, an important factor, and makers of tinplates are by no means anxious to book option contracts at the fixed price.

Metals.

Copper.—Messrs. Henry Bath & Son, Limited, in their fortnightly metal report, state :—Fluctuations during the past fortnight have been moderate, with, generally, a rising tendency. The lowest price touched for three months was £62 7s. 6d., and the highest £64 per ton. Home demand has been continuous, but moderate. There has been such a steady absorption of the scrap arising from the breaking down of war material, etc., that these supplies are, comparatively speaking, now worked off, and consumers are falling back more and more on virgin metal. A big increase in Chilean production is apparently a matter of perturbation to the American producers, in spite of the fact that American consumption has expanded materially and is still quite good. Current quotations :—*Cash* : Wednesday, £62 17s. 6d. ; Thursday, £62 15s. ; Friday, £62 12s. 6d. ; Monday, £63 5s. ; Tuesday, £63 10s. *Three months* : Wednesday, £63 12s. 6d. ; Thursday, £63 10s. ; Friday, £63 10s. ; Monday, £64 ; Tuesday, £64 5s.

Tin.—The advance recorded in our last continued steadily until a sharp rise at the beginning of this week culminated in an excited market on the 31st ult., when £186 15s. was paid for three months. Heavy realising has caused a fall, with sharp fluctuations, of about £7 per ton. The turnover on 'Change has on some days reached exceptionally large dimensions, speculative buying and selling being freely indulged in. America has only been buying small quantities, whereas it is asserted that her uncovered requirements are very large. The East has sold fairly steadily at full prices but not in big quantities, and although shipments are well up to the average the figures of visible supply as at October 31 show a decrease of about 500 tons. Current quotations :—*Cash* : Wednesday, £180 5s. ; Thursday, £179 2s. 6d. ; Friday, £183 15s. ; Monday, £187 7s. 6d. ; Tuesday, £184 15s. *Three months* : Wednesday, £180 15s. ; Thursday, £179 17s. 6d. ; Friday, £184 5s. ; Monday, £187 15s. ; Tuesday, £185 5s.

Spelter.—A steady advance was seen in this market until the 26th ult., when £37 10s. and £36 were the closing quotations. Since then the market has been firm with slight alteration in price for near but with an easier tendency for distant delivery. The rise in price has led to America furnishing supplies to this market to the detriment of the limited available stock there. Supplies from the Continent continue very meagre. The galvanising trade is very busy and has bought freely. Current quotations :—*Ordinary* : Wednesday, £37 5s. ; Thursday, £37 5s. ; Friday, £37 10s. ; Monday, £37 15s. ; Tuesday, £37 17s. 6d.

Lead.—In the early part of the fortnight prices eased off until the 20th ult., when the quotations were £24 15s. and £24 7s. 6d. per ton prompt and forward. A somewhat unexpected shipment of about 1,500 tons of Mexican lead overshadowed the market, but the rapid absorption was followed by a quick recovery in prices, the market later experiencing an advance of £1 15s. per ton for October lead and £1 for forward. Sharp movements have continued, the highest quotation being on the 26th ult., viz., £27 for October, and £25 10s. for January. Home consumption is quite good, and in America the position is reported to be strong. The present level of prices, however, should bring out increased supplies. Current quotations :—*Soft foreign (prompt)* : Wednesday, £26 10s. ; Thursday, £26 ; Friday, £26 10s. ; Monday, £26 10s. ; Tuesday, £26 10s.

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THE

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Contents.

	PAGE
Electric Furnaces and the Foundry	397
Correspondence	398
The British Cast Iron Research Association	398
Iron and Steel Output in October	398
A Sand Mill Trouble	398
A Visit to the North-Eastern Marine Works	399
Non-Magnetic Cast Iron	402
An Apprenticeship Course in Foundry Practice.—XVIII.	403
Foundry Goggles	404
Electric Alloy Steels	405
Riser Shapes	406
The Manufacture of 30-in. Flexible-Joint Cast-Iron Pipes	406
Institution of British Foundrymen	407
Analysis of Iron and Steel	411
Growth and Deterioration of Grey Cast Irons under Repeated Heatings	412
Thermal Expansion of Metals	414
Coalbrook-dale Bridge	415
Synthetic Pig-iron on the Pacific Coast	415
Compressed Air Film	415
Trade Talk	416
Company News	416
Gazette	416
Iron and Steel Markets	417

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Electric Furnaces and the Foundry.

Since the war, the electric furnace for steel making has not greatly expanded, few sales of new plant having been recorded, but distinct advances have been made both in the iron foundry and the non-ferrous industry. In this country, however, the progress even for the two latter industries has been distinctly limited. This, we believe, to be due to trade conditions and not to lack of technical interest. Mr. Elliott's Paper before the Blackpool Convention resulted in perhaps the most voluminous discussion of any paper ever presented to British foundrymen. An excellent review of the present situation has recently been made by Mr. John A. Matthews before the American Iron and Steel Institute. The point which he emphasised most was the subject of inclusions. He credits Prof. H. F. Moore and Dr. McCance with proving that failures under repeated stress originate in either inclusions or surface defects. He (Mr. Matthews) illustrates this by pointing out that basic and acid open hearth and basic electric steel made to the same chemical specification for aeroplane crank shafts, the defects due to hair line cracks were in the proportion of 8 to 4 to 1. If non-metallic inclusions have such a bad effect on steel it is reasonable to suppose that their absence or distribution accounts for the superior tests given by electrically melted cast iron. We include the disposition of the graphite in this category. It should be remembered that electrically melted cast iron of cylinder quality will give between 19 and 20 tons per sq. in. tensile. Another feature of the electric furnace is its flexibility. The furnace can be acid, basic or neutral as to the character of the lining and oxidising, reducing or neutral as to the nature of the atmosphere. Tricks of the trade which have been found to be efficacious in allied processes can be incorporated in the electric furnace. For instance, according to Messrs. H. M. Williams and T. B. Terry, in a Paper presented to the American Electrochemical Society, the tranverse test on electrically-made normal cast iron varies between 3,220 and 3,610 lbs., whilst the addition of 20 per cent steel gave tests ranging betweeo 4,250 and 4,680 lbs. These tests were made under standard American Society for Testing Materials conditions.

A feature not realised by all foundrymen is that returned scrap improves on electrically remelting and not deteriorates as in cupola or crucible practice. In some parts of Great Britain electrical energy can now be purhased for just under one penny per unit, which should bring the process within the range of commercial exploitation; for castings which incorporate a maximum of moulding costs, and the uso of expensive iron. Undoubtedly duplexing—that is refining cupola-melted metal—would be the cheapest method of working providing sufficient orders could be booked to keep the plant fully occupied. Intermittent working will damn any duplexing system.

It is not generally known that Italy ranks second only to the States as a manufacturer of electric furnace products, and the production of excellent synthetic cast iron by that country may have a profound influence on the whole of the European foundry industry. As buyers, they will be more critical of the castings incorporated in imported machines, and it is probably that it is only their lack of knowledge of foreign requirements which prevents their competition being felt in Western Europe.

The question naturally arises as to when will British foundrymen start their experiments. At the moment this work is confined to an extremely limited number of manufacturers. The iron foundry trade starts its career in a very much better condition than did the steel ingot manufacturers. They had to start with metallurgical monstrosities, whereas, nowadays, there are a choice of furnaces which are finished articles. Mr. Matthews, in the address previously cited, refers to an instance where electrode costs were from 33s. to 1s. 6d. per ton. It is at the economical end of the scale at which the iron foundryman starts. We believe that it will not be for the purpose of replacing existing plant that the electric furnace will be adopted in the iron foundry, but rather to meet new demands, which will be placed upon the industry in the future.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Steel Foundry Facing Sand.

To the Editor of The Foundry Trade Journal.

Sir,—"Steel Fonndryman" would be well advised to discontinue the use of the expression: "Grinding a steel foundry sand"—as to "grind" is to reduce to powder, in this case sand grains, and finely ground sand or silt are objectionable ingredients in a "steel foundry facing sand."

If necessary to mix 20 per cent. silicious clay with 80 per cent. silica sand, this should be done dry—*i.e.*, both materials stored until dry—after which the desired quantities mixed in a pan mill having medium weight rollers of an adjustable character. Only just sufficient water should be added to produce the necessary strength. After mixing in this way the mixture may be put through a "whizzer"—but in all probability a mixture of 20 per cent. real silicious clay and 80 per cent. silica sand would have both its moisture and strength dissipated in a "whizzer"—consequently "Steel Foundryman" must adjust his ingredients accordingly to make such a method practical.

Yours, etc.,

Algernon Lewin Curtis.

Westmoor Laboratory, Chatteris.

To the Editor of The Foundry Trade Journal.

Sir,—I have pleasure in informing "Steel Foundryman" what I consider to be the best method of grinding and mixing the facing sand in question.

In using silica sand and clay for steel foundry facing sand great care must be taken in assuring that the clay is properly disseminated throughout the silica sand, but by grinding it wet, in a mill with flat rollers, it is impossible to get the clay equally distributed.

In the first place I suggest that all the clay should be dried, and the silica sand should also be fairly dry. Then the sand mill should have V-grooved rollers, as by using flat rollers in the mill no mixing takes place; it only rolls the sand into hard cakes as "Steel Foundryman" has noted. If the mill is fitted with V-grooved rollers and an inside scraper, he should have no difficulty in mixing the sand.

It would be, of course, much better if the sand, after leaving the mill, was put through a sand mixer. If the rollers suggested are fitted, and the clay and sand fairly dry, there should be no difficulty whatever, but if "Steel Foundryman" continues to add the clay in a mill he is already using, and in a wet condition, he will certainly continue to have difficulty in obtaining a uniform mixture, and no doubt castings produced from such a sand mixture would be far from satisfactory.

Yours, etc.,

G. T.

To the Editor of The Foundry Trade Journal.

Sir,—We have noticed the letter in your correspondence column from "Steel Foundryman" *re* grinding clay.

We have had considerable experience in this line with a similar clay, and have found the only way to deal with it is to dry the clay and then crush it to a powder, mixing it with the silica sand afterwards in a pug mill. Another way (but much longer) is to soak the clay well until it is in a soft plastic condition, when sufficiently plastic it is mixed with a silica sand in the pug mill.

Your correspondent would be well advised to obtain the clay in dried powder form, a material already on the market.

Yours, etc.,

Per Pro Thos. E. Gray & Co., Ltd.,

Thos. H. Gray.

119, High Holborn, W.C.1.

The Hestia Core Oven.

To the Editor of The Foundry Trade Journal.

Sir,—I read with great interest your article on the "Hestia" core stove in your last week's issue.

There is certainly room for new ideas in core stoves, and as a practical moulder who has had some experiences of the gloomy dungeons now in use, I welcome this attempt to improve matters.

Of course the deciding factor is efficiency, and I should like to know if the makers have had any experience in the drying of barrel cores by this method, and if the heating stove requires any attentions during the night?

Trusting that your contributor will be able to supply this information.

Yours, etc.,

A Foreman Moulder.

Visit to France.

To the Editor of The Foundry Trade Journal.

Sir,—With regard to your appeal in the "F.T.J." of October 26, I should be very pleased if you could now add my name to the list of those participating in the Paris Congress and Exhibition.

It would seem to me a rather good plan if each Branch of the Institution of British Foundrymen would send at least one of its members, who on returning would be able to do something to stimulate further interest amongst his local members in International Foundry Conferences.

Yours, etc.,

E. Harwood Brown.

91, Devonshire Road, Forest Hill, S.E.23.
November 10, 1922.

The British Cast-Iron Research Association.

The ordinary general meeting of the British Cast Iron Research Association will be held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, on November 23, 1922, at 3.30 p.m., for the following purposes:—(1) To receive and consider the accounts, the balance-sheet, and the reports of the Council and the auditors; (2) to elect members of the Council; (3) to appoint auditors and fix their remuneration; (4) to consider, and if thought fit, to resolve upon an amendment to Article 15 in regard to the rates of subscription as follows:—"In the case of any foundry employing not less than fifty persons actually moulding, all of whom are unskilled, a rebate of 50 per cent. upon the rates specified in Article 15 (*e*) will be allowed to the member.

"In the case of any foundry employing not less than fifty persons actually moulding, a portion only of whom are skilled, a rebate of 25 per cent. for the unskilled moulders upon the rates specified in Article 15 (*e*) will be allowed to the member." (5) To transact any other ordinary business of the Association.

Iron and Steel Output in October.

The National Federation of Iron and Steel Manufacturers, in their monthly report on the iron and steel output in October, state that the production of pig-iron amounted to 481,500 tons, and of steel ingots and castings to 565,200 tons. Although the production of pig-iron is the highest since the coal stoppage, it is still only 56 per cent. of the average monthly production of 1913. Included in the production of pig-iron are 129,900 tons of hematite, 151,100 tons of basic, 134,000 tons of foundry, and 31,500 tons of forge pig-iron.

A Sandmill Trouble.

Mr. John Riley, M.Sc., of 3, Glen Road, Lees Road, Oldham, would esteem it a favour if E. M., who answered S. E.'s query with regard to the above in our issue of October 20, 1921, will communicate with him.

A Visit to the North-Eastern Marine Works.

On October 21 the Members of the Newcastle Branch of the Institution of British Foundrymen were invited by Mr. Summers Hunter, managing director of the North-Eastern Marine Engineering Co., to visit the Wallsend Works.

About 200 took part, and were received in the main entrance hall, where a model of a quadruple expansion marine engine, built to scale, was running alternately ahead and astern.

Group Photograph of the Visitors Taken on Arrival at the Wallsend Works.

Address of Welcome.

Mr. Summers Hunter welcomed the guests, saying that he was a great believer in gatherings of this kind. He thought it a matter of interest that some 60 or 70 years ago the place on which they were standing was a slake something like that at Jarrow, and the land on which the Works were built was formed of ballast. Another item of interest which Mr. Hunter mentioned was the large crane, the foundations of which are as deep as the crane stands high above the ground.

They had had many distinguished visitors since the Works were built, among them being Royalty. Lord Kelvin had paid a visit to the Works when they were the largest in the country to be driven by electricity.

Mr. Hunter, in closing his speech, said he hoped that the visitors would see something of interest and, perhaps, be able to point out to them some of their shortcomings. He was afraid that, owing to the depression in trade, the works looked more like a storage house for machinery than an engineering works, but at the same time considered that they were a little better off than some works and so had something to be thankful for. On their tour round the Works the visitors would see turbines which were more or less common property now, and also the reciprocators which are still in use.

The Laboratory.

After Mr. Hunter's address the visitors inspected the metallurgical laboratory. Round the first room, which contained transverse and Brinell machines, were shelves of test-bars all numbered so that if necessary any particular bar could quickly be referred to. The main laboratory is fully equipped for all routine analyses, and is fitted with fume cupboards and electric fans to keep the department free from fumes. Included in the equipments is a large number of pyrometers and recording instruments which are used, amongst other things, for determining temperatures of molten metal. Another interesting feature is the oil and fuel laboratory, where bomb calorimeters are used for determining calorific values of fuels, a Pensky Martin's apparatus for

Fig. 1.—South Portion of the Pattern Shop. Messrs. The North Eastern Marine Engineering Company, Limited.

determining flash points, a Redwood viscometer for determining viscosities of oils, and an Orsat outfit for gas analyses. The dark room is provided where specimens are examined and photographed by means of a "Swift" photo-micrographic outfit and optical bench. The micro specimens were numbered and classified so that any particular one required could be found immediately. Attached to the laboratory are two buildings for tensile testing and sampling.

Fig. 2.—The West Bay of the Wallsend Foundry. Messrs. North-Eastern Marine Engineering Company, Limited.

Foundries and Shops.

This firm utilises an auxiliary foundry for Diesel engine work, and here the visitors were shown a cylinder which had just been cast. Bins for storing various pig-irons, the weigh house, and an electric hoist to the cupola charging platform all received special attention. The main foundry is fitted up with electric overhead and a number of pneumatic and hand cranes.

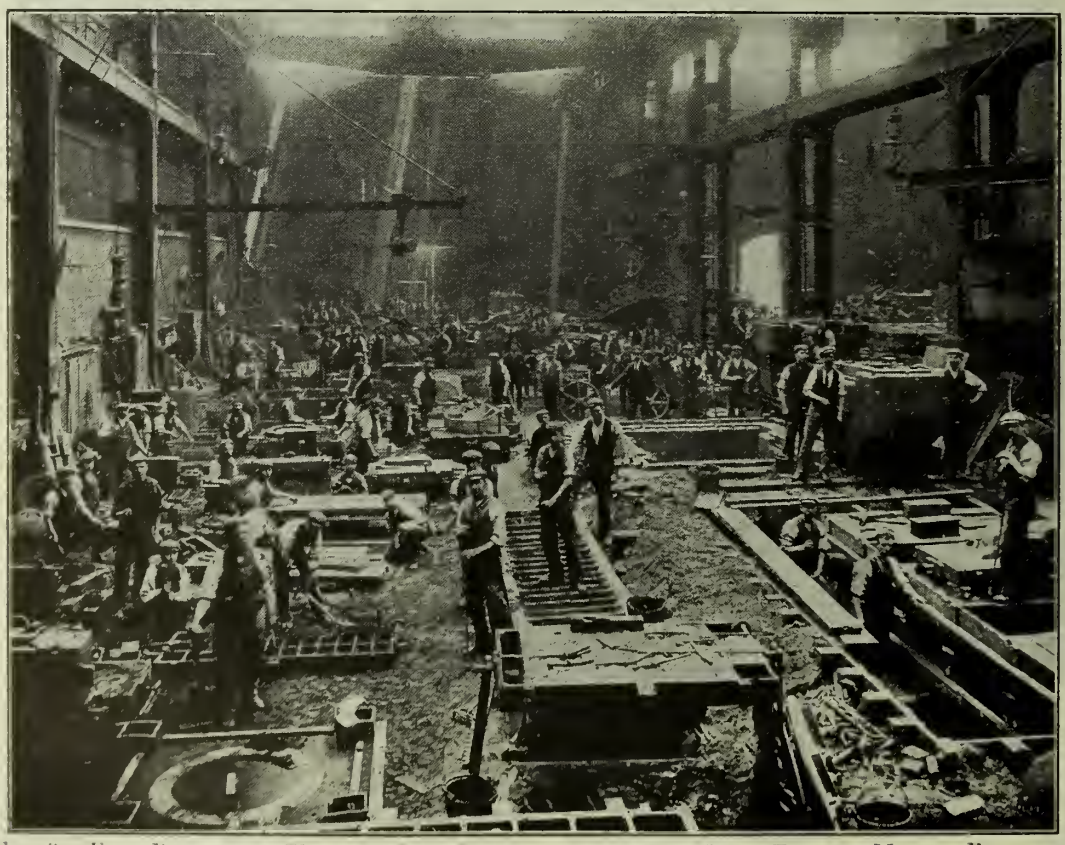


Fig. 3.—East Bay of the Wallsend Iron Foundry. Messrs. North-Eastern Marine Engineering Company, Limited.

The pattern shop is a large building containing

all the usual modern tools and appliances. In the superheater shop, where the "North-Eastern" smoke tube superheaters are made, the visitors were shown how the headers were machined from solid steel blooms, the tube-bending and cap-welding.

At the time of the visit a large batch of Diesel engine cylinders were passing through the machine shop. They were partly machined and waiting to be annealed.

The brass finishing, the brass foundry, and the erecting shop were each inspected, the last of which contains several 150-ton high-speed cranes. Finally the boiler shop, with its hydraulic riveting machines, hydraulic flanging machines capable of dealing with the heaviest class of work, and rolls for rolling boiler plates was inspected.

It is interesting to note that compressed air connections are fitted in each department and portable tools are very extensively used for drilling, grinding, chipping, hoisting, etc.

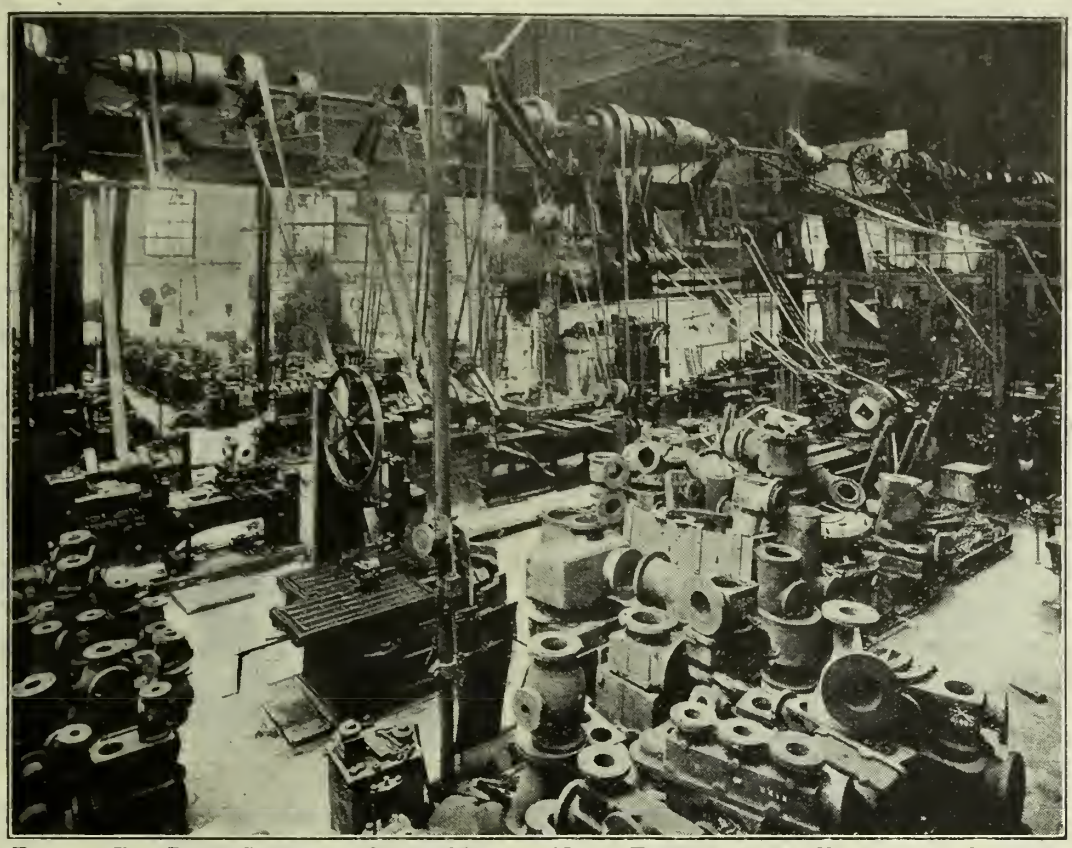


Fig. 4.—The Brass Finishing Shop. Messrs. North-Eastern Marine Engineering Company.

Votes of Thanks.

After visiting the drawing office, the visitors were entertained in the works canteen to an excellent tea, after which Mr. H. J. Young, Branch-President, in proposing a vote of thanks to Mr. Summers Hunter for throwing open the works to the Institution, said Mr. Hunter had always stood for science, and when he (Mr. Young) first came to the firm about twelve years ago there were certain foremen who were his first friends in the ironfoundry trade and who are still with the Company and still his friends. When one considers the fact that the motto of the Institution is "Science hand in hand with Labour," and how difficult it is to combine the two, much credit is due to Mr. Hunter who has brought it about so that he, the chemist, and the foundrymen are working together for the common good. Mr. Summers Hunter's effort was an example to all Tyneside, and the Branch in return should show what it can do to educate people. Mr. Young then formally proposed a vote of thanks to Mr. Hunter,

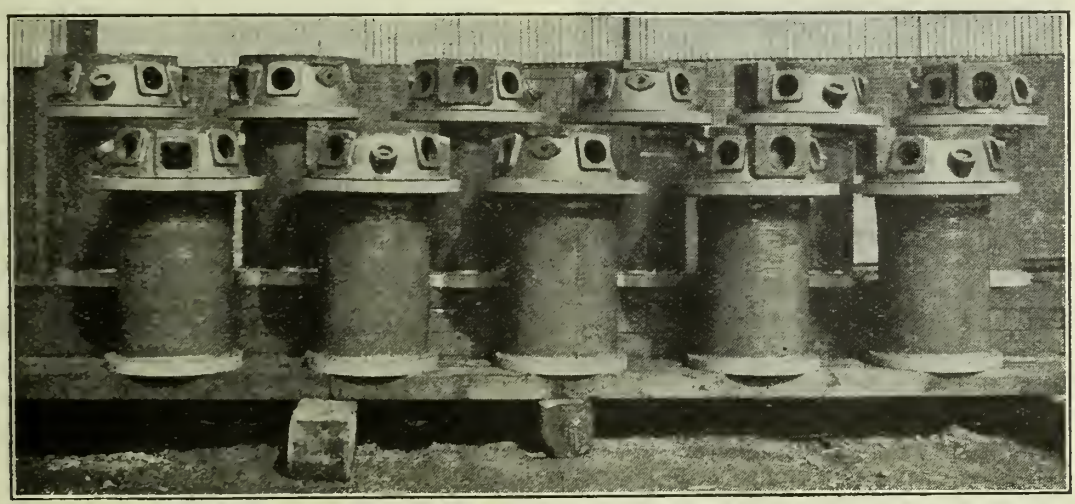


Fig. 5.—A Group of Diesel Engine Cylinders. Messrs. North-Eastern Marine Engineering Company.

coupled with the names of Messrs. Luhrs and Wood and all others who had done so much to make the visit a success.

Mr. Luhrs, replying, said that Mr. Hunter strongly supported the Institution, as it brought science and practice together.

Mr. J. Paulin said that Mr. Hunter's name was a household word on Tyneside. With reference to

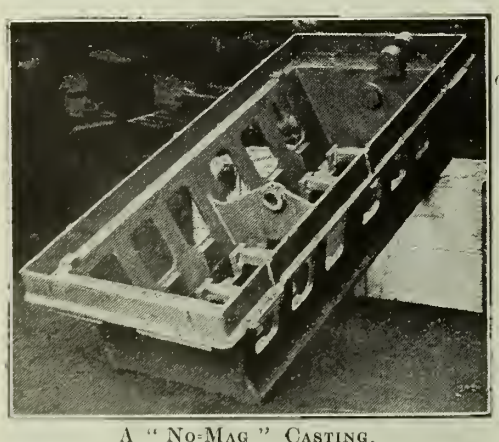
science, he had heard much from Mr. Young about it and had always received it in a more or less criticising manner, and after having seen all, he did not think that a man with the sagacity of Mr. Hunter would lay out such an enormous sum of money if there was not something in it. He had great pleasure in seconding the vote of thanks to Mr. Hunter and to all the officials who had helped to entertain everyone so kindly.

Mr. S. W. Wise, in a few remarks, said that one of the advantages of a visit of this kind was the bringing of those in control of works more closely in contact with those who do the work, and he wished to join in thanking their host for the kind way in which they had been entertained that afternoon.

Non-Magnetic Cast Iron.

The necessity for a metal having similar magnetic properties to brass and gunmetal, but in price more nearly approaching that of cast-iron, has been the long-felt want of manufacturers of electrical plant and apparatus, and has led Mr. S. E. D. Dawson, A.M.C.Tech., A.I.C., chemist and foundry manager to Messrs. Ferranti, Limited, to conduct a series of exhaustive experiments, the outcome of which has been the evolution of a non-magnetic cast-iron, which is being manufactured at their Hollinwood Works, Manchester, under the Dawson-Ferranti patents. The metal is distinguished by the name of "No-Mag," and is an alloy possessing not only the features of gunmetal which are essential in the design and construction of electrical machinery, but also having a higher specific resistance than ordinary cast-iron. Such a metal may well have a revolutionary effect in the construction of electrical apparatus, as its use eliminates magnetic hysteresis, and the losses due to eddy currents are reduced to a minimum. These advantages are not jointly obtainable with any other metal or alloy in commercial use. The magnetic permeability of ordinary cast-iron is 330.00, whilst for "No-Mag" it is only 1.03, and for brass 1.00; the specific resistance in micro-ohms per cm. cube being 95.0, 140.0, and 7.5 respectively.

It will be obvious that by the use of such a metal in the construction of an alternator the hysteresis and eddy losses in the stator end plates are reduced to a minimum, and magnetic leakage is largely removed. The same applies to the end covers over the end connections. In the case of armatures or rotors of direct- or alternating-current generators or motors, by the use of the new metal in the end plates the total flux is kept particularly confined to the armature core, and magnetic leakages are again reduced to a minimum, the latter being important from the point of view of the reduction in the amount of copper which may be used.



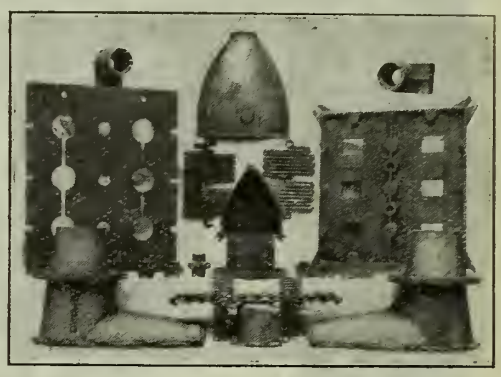
A "No-Mag" Casting.

The iron can be cast with the same facility as ordinary cast-iron, brass, and aluminium, and has the same appearance as the former, with which it also compares equally as regards strength and machining properties. In tensile and transverse strength it follows the usual figures for cast-iron, but it has the advantage of increased toughness and malleability, which is observed both in the transverse deflection and in its resistance to shock. The increased toughness as compared with ordinary cast-iron is also shown in the Izod test, the figures being given in the accompanying table, for purposes of comparison, along with those for two samples of ordinary cast-iron. This test was carried out upon a larger bar than usual, in order to show up more clearly the differences between various grades of cast-iron:—

		Sample 1.	Sample 2.
Cast-iron	Carbon	3.36	3.38
	Silicon.. ..	1.81	1.99
	Phosphorus	0.46	0.79
	Tensile strength (tons per sq. in.).. ..	14.80	14.10
	Izod (ft.-lbs.) ..	14.00	11.00
No-Mag Izod (ft.-lbs.)		29.00	—

The test bar was 20 mm. × 20 mm. × 75 mm.

The chief characteristics of a non-magnetic cast-iron are:—(1) Low magnetic permeability; (2) high specific resistance; (3) low resistance temperature-coefficient. "No-Mag" is slightly less permeable with increasing temperatures; at 17 deg. C. the permeability is 1.025, whilst at 100 deg. C. it decreases to 1.020. This property of low permeability enables the metal to be used in place of brass, especially where there is danger of undesired eddy currents, and its uses in this direction cover a large field. Moreover, the specific resistance of the new metal, showing an increase of 50 per cent. over cast-iron, suggests the use of this material in cases where increased resistance with smaller volume of metal or similar resistance with extra metal for strength would be an advantage, such as in resistance grids. Further, "No-Mag" has a resistance temperature co-efficient between 0 deg. C. and 100 deg. C. of 0.0009 per 1 deg. C., as compared with approximately 0.0019 per 1 deg. C. for ordinary cast-iron.



A Group of "No-Mag" Castings.

The cost of "No-Mag" is, as with other irons, somewhat dependent upon the type of casting, but it may be taken as being 20 per cent to 50 per cent. higher in price than grey iron. When compared in price with that of gunmetal, however, its advantage as a substitute for that metal is obvious from an economical point of view. Amongst the applications of "No-Mag" may be mentioned oil-switch covers, bus-bar clamps, brackets, cable boxes, sealing bells, bearing covers, separating pieces, transformer covers, etc.

Our representative was given an opportunity to inspect the castings passing through the foundry at the time of his visit, and of the clean finish of these our illustration furnishes ample testimony, but the remarkable flexibility of the light resistance grids must be seen to be appreciated. Messrs. Ferranti have a foundry laid out specially for the manufacture of "No-Mag" iron castings for the trade, but we understand that they are also prepared to supply the alloy in the form of pig-metal ready for charging into the cupola or melting furnace.

The Russian Gomza Syndicate.—The Gomza Syndicate represents a combination of eleven works in Central Russia. At present 55,715 people are employed. The total capitalisation of the Syndicate is 69,730,000 pre-war roubles. The output value of the syndicated engineering and machine works amounted during the first six months of 1922 to about 10,000,000 gold roubles (about £1,057,000). About 98 per cent. of all transactions of the Gomza works were concluded with State institutions, with barter transactions predominating.

An Apprenticeship Course in Foundry Practice.—XVIII.

By Ben Shaw and James Edgar.

LATHE WORK.

Value of Confidence.

There is more bad workmanship at the patternshop lathe than at the bench. Many first-class patternmakers are very inferior turners, and apprentices usually find it much more difficult to acquire skill in the use of turning tools than with bench tools. Yet turning is not difficult. It is largely a matter of confidence, and there is no reason why anyone of ordinary intelligence should not become efficient at wood turning in a very short time. We refer, of course, to pattern turning, because there are essential differences between this class of turner and the man who is skilled in ornamental work. It is the quality of confidence that makes the mediocre craftsman, in some cases, quite good turners. Confidence can be overdone, but it is n fact that most of the accidents that happen at wood-turning lathes are caused by the lack of it. Confidence is not rashness, as is sometimes assumed. Old hands are always ready to confess that lathe accidents they may have had have resulted from timidity. Not always, of course, because many factors, such as correct turning speed, proper centring of work and vibration have to be taken into account, but invariably so. The wood turner needs confidence, but he also has to exercise caution. His motto must be "Safety first and all the time." When in any doubt as to whether work is secure, it is best to stop the machine and, if necessary, dissemble the job. There should be no question of taking risks. The work should be well built and securely fastened on the faceplate or between the centres, and then the patternmaker has every assurance that all will be well. It is no uncommon thing for a boy or young journeyman to be seen standing well back from the lathe with one arm raised to protect him if the work does break away, and pushing the tool forward on the rest nervously. We shall discuss actual turning further on, but it should be obvious that the man or boy who thus anticipates an accident is going half way to meet one.

Pattern and Ornamental Turning.

We have spoken of the difference between pattern and ornamental turning. The turner in the cabinet shop does not, unless in exceptional cases, use templates. Much of his work is turned "to the eye"; the patternmaker, on the other hand, is not working for effect, but to accurate measurements; thus he either uses templates or callipers. The highly-skilled man does not use templates to the same extent as the man of lesser skill, because he can turn rounds and fillets very accurately "to the eye" without them. It is, however, safer, when dealing with convex and concave surfaces, to be guided by a template, and especially so if the metal is thin. Oftentimes it is possible, by callipering several diameters roughly to size, just larger than the required size, to economise in time, because to use a template, even when roughing down work, is an exceedingly slow process. We have seen a man rubbing on the work with a template for a day, when a more intelligent man would have roughed it down to within 1-16th in. of the size in a few minutes and finish off with a template in not much more time. A soft wood template is never as satisfactory as using two or three hardwood straight edges. Sometimes, however, a pattern can be better turned without a template, but the template may be indispensable for marking centres for bosses or ribs that have to be fitted, when the work is taken to the bench, or it may be to get centre lines for the joint face of the pattern when it has been removed from the lathe.

Turning Speeds.

The authors of some books on patternmaking have very ingeniously worked out to their own satisfaction the correct turning speeds for different classes of work. It may be very nice for the non-technical man to know, when the speed of the countershaft of a wood-turning lathe is known, that by multiplying the number of revolutions per minute of the countershaft by the diameter of the step on the countershaft cone, on which the belt is to run, and dividing by the diameter of the corresponding step on the lathe cone, that the result will be the revolutions per minute on the lathe spindle, and also that a speed of 3,000 r.p.m. is suitable for one size job and 2,000 r.p.m. for another job, but to carry this system to a logical conclusion, change pulleys would have to be used or some form of expanding pulley. This might be a more scientific way of turning than is at present available, but here we shall not concern ourselves with what *might be*, but with what *is*. We do not suggest that a safe cutting-speed should not be observed, but, supposing the cutting-speed should be approximately 2,000 ft. per min., then, when turning work of 3 in. dia., the number of revolutions should be about 2,540, while, if the work to be turned is of 5 ft. dia., the lathe would need to revolve about 127 to the minute to obtain the same cutting speed, but the equipment of the patternshop must be considered and, incidentally, the rigidity of the lathe or lathes, before an approximation can be determined of the most suitable cutting speed for any given work. If many lathes are installed, there is a bigger choice of speeds, but if the patternshop only possesses one lathe, the number of speeds is governed by the number of steps on the cone pulley; thus the choice is limited to three or four, and sometimes very small work has to be turned in a large lathe.

With medium-sized and large work, it is usually safer and more satisfactory to rough-down on a comparatively slow speed and finish on a faster speed, but with delicately-built work it is sometimes advisable to begin and finish on a fast speed; it depends largely on the manner in which the work is balanced in the lathe. Centrifugal force has to be considered when turning, and, if the work is unbalanced, it is desirable to rough-down on a lower speed to obtain balance; otherwise the vibration may be such as to cause the job to fly out. It is this vibration that frequently determines the speed. It is much easier and safer to turn work of small diameter at a very high speed. It is almost, though not quite, true to say that large work, work, that is to say, of 5 or 6 ft. dia., cannot be turned too slowly.

The Slide Rest.

The slide rest, with which only very few patternshops are equipped, is useful up to a point. For straight barrel work it may be quicker than using the ordinary T-rest, but its usefulness is limited to cylindrical turning. It is sometimes used for face-plate work, but is not really satisfactory. Sometimes also it may be used for internal turning, where the depth is considerable and it is impossible to get the T-rest close to the work. The working patternmaker has to use such rests as are supplied, but it may not be out of place here to urge on foremen and managers the economy of equipping lathes with a variety of rests. Work is frequently spoiled just when being finished off, because there is not the requisite support for the tool, owing to the rest being too far from the face being turned. It takes much longer to turn work with the rest several inches from the face than when it is almost touching and is perfectly rigid. The T-rest, in one form or another, is undoubtedly the best for all-round pattern turning.

Centres.

In addition to rests, both large and small lathes have fork and cone centres. The forked chuck is sometimes called a "swallow-tail" and sometimes a "butterfly," and it is not always in the best condition. The forked centre is the driving centre, and the shank which enters the lathe spindle is tapered, making a frictional contact with the spindle only, and it is not necessary to drive it in position—a practice which is so common—as that is the quickest way to destroy the accuracy of the centre. These centres are quite

satisfactory for small work, especially if it is not in halves; when it will probably be necessary to remove the work from the lathe to fit flanges, however, it is necessary to use either hardwood or iron centre plates to ensure that, when the work is replaced in the lathe, it will run true. To save time, patternmakers sometimes take the risk and do not use plates for such work, but the result is seldom quite satisfactory, and it may be doubted if, in the long run, any time is saved.

Hardwood centres are quite all right for work that is not more than about 6 in. dia. A common way of making them is to cut the circles at the bandsaw, screw the centres on each end of a piece of timber, cut the discs to engage the forked and cone centres respectively, and then turn the peripheries in the lathe. Afterwards, when setting on the ends of a job, circles should be inscribed on the ends of the material the same diameter as the plates. It is better, however, after turning them, to divide the peripheries into four parts in order that they can be set to centre lines; this ensures very accurate setting and little subsequent adjustment. According to the diameter, the hardwood faceplate should not be less than ½ in. thick, and need not be more than 1 in.

Iron faceplates screwed on to the mandrel of the headstock are used for all work that is best turned without the aid of the cone centre. It is seldom that patternwork is screwed directly on to the iron faceplate, perhaps the chief reason for this being the probability of the workman's tool touching the iron. A wooden faceplate or chuck is invariably screwed to the iron faceplate and turned. For large barrel work, the forked centre is not sufficient, and the screwed faceplate is frequently used together with the cone centre, but the end of the barrel carrying the faceplate needs to be square; otherwise there is difficulty in securing alignment. Because of this difficulty it is better to use two cone centres in the lathe, and a plate is usually screwed to the end of the barrel, which has a pin rivetted to it, and this pin slips into a hole in the ordinary faceplate which carries a cone centre. Another plate is secured to the other end of the barrel, and both these plates are countersunk to take the cone centres. The action is similar to that adopted when turning between centres in a metal turning lathe; thus, when the lathe is started, the job, which swings on the two centres, is driven by the faceplate driving the pin. These iron centre plates are usually made about ½ in. thick and of 6 in. dia. or more. There are a number of variations of the same principle, but in those used which have freedom for half-a-turn before the pin engages, care must be exercised to ensure that the pin engages before the lathe is started. It is better to secure them at the outset; otherwise the work may be thrown out of centre.

When screwing faceplates on the lathe spindle, apprentices and some journeymen have a habit of forcing it against the shoulder, and much time is occupied in its removal afterwards. The writers have seen instances when it has been necessary to expand the faceplate in a final effort to remove one so firmly fixed. This can be obviated by using a thick paper washer between the faceplate and the shoulder on the lathe spindle.

Preparing Work for the Lathe.

Good results in pattern turning depend to a very great extent on the preparation of the work. Time spent at this stage is saved when the work is turned between centres or on the faceplate. It is not uncommon for patternmakers to start turning knowing perfectly well that they will have to stop before long to punch in nails or take out screws. It should never be necessary to do so, and the greatest care should be taken, in building the work, so that all nails and screws are clear. It is not advisable to make a fetish of glue, but it is never a disadvantage to glue work that has to be turned; glue may serve the purpose of holding the work together while it is being turned, and afterwards the joints can be reinforced with screws. In all but the most exceptional cases, however, it is practicable to do the screwing and nailing necessary before the job goes to the lathe.

While, in segmental work, it is advisable to leave ¾ in. dia. for turning and about ⅛ in. on faces, it is not necessary to build a barrel more than about ⅛ in. above the finished diameter. A great deal of timber is wasted in turning, and the waste can be reduced with careful building and centring. Small cylindrical bodies should be got out ¼ in. or ⅜ in. larger than the finished diameter, and in turning these much timber is frequently wasted by getting them out longer than is necessary. If a pattern is in halves, it is advisable, in addition to centre plates, to insert screws at both ends, and this does not necessitate leaving much extra length. For solid work, 2 in. greater than the pattern length is usually sufficient, and, when in halves, about 3 in. This allowance serves to clear the work and also to clear end screws. Small cylinders should never be turned from square; it is frequently done—and successfully—but the risk of the work being torn from the centres by the tool is great. It is a simple matter to plane or saw the corners, making a rough octagonal block. When turning at a high speed between centres, or even in the case of large work when revolving at a slower speed, the tailstock centre is very apt to run hot. All sorts of ingenious contrivances have been tried to obviate this by ensuring a continuous drip of oil on the centre, but a very effective method is loosely to tie a rag or piece of cotton-waste round the mandrel and keep it well soaked with oil, or, when the wood is running direct on the centre, tallow should be used as lubrication. The heating of the cone centre, especially when turning hardwood, is often due to bad adjustment; when the work is placed between the centres, the cone centre should be engaged sufficiently to stop vibration, but the work should turn freely when the cone pulley is turned with the hand.

When turning large barrels, in addition to iron centre plates, it may be necessary, if the plates are not of large diameter compared with the diameter of the work, to screw additional battens on the ends, or sometimes dogs may serve the purpose. If the work is very long and in halves, centrifugal action will tend to force the two halves apart, and experienced workmen usually insert screws about the centre, or dogs may be used. When the latter, the barrel is finished, excepting for an inch or so at the centre, which is finished finally. The objection to dogs is that they prevent, in the case of a straight length, the use of a straightedge from end to end, which is a considerable disadvantage, and it must also be remembered that there is a possibility of dogs flying out. When turning parallel cylinders, the best method is to finish off an inch or so at each end to the required diameter, and then use a straightedge. Experienced workers will turn a barrel in this way in a very short time. Callipers would be used, of course.

Foundry Goggles.

A feature of the Motor Show, which could not fail to attract the attention of foundrymen, was the exhibit of the Triplex Safety Glass Company, Limited, of 1, Albemarle Street, London, W.1. Speaking as a layman, we imagine triplex glass to be something of the nature of three-ply wood, but with the centre layer made of some type of celluloid. A wind screen was shown which had stopped a bullet in Ireland. This material, on being struck by a flying fragment, merely "stars," no piece ever becoming detached. The foundry presents a large field for the use of goggles made from this material, as spectacles are worn on the steel-melting plant, fettling, sand blast, and welding shops. We understand that physicians' prescriptions can be incorporated in the glass, and blue, smoked, and chlorophyl lenses are marketed.

THE INSTITUTION OF PRODUCTION ENGINEERS.—A meeting will be held on November 24 at the Engineers' Club, Coventry Street, London, at 7.30 p.m., when Mr. G. Hey will deliver a Paper dealing with "Standardisation." All interested are invited to attend, whether members of the Institution or not, and no tickets are necessary.

Electric Alloy Steels.

Probably no one has done more to interest foundrymen in the question of alloy steel castings than Signor F. Giolitti, and it is pleasing to find that other workers are now following his lead. On the Pacific Coast of America, the Los Angeles Foundry Company are already marketing such products. A good deal more light is thrown on the subject by Mr. Larry J. Barton, of Los Angeles, in an article in a recent issue of the "Iron Age," from which we take the following abstract:—

There are many classes of work, formerly made of manganese steel, which are now made from other alloys. This is due to the fact that manganese steel cannot be machined, and if there are any small variations in the casting, it cannot be used unless put through the necessary grinding to alter it. Then, too, when the piece is scrapped, due to wear, it cannot be used for any other purpose. Alloy castings are made to overcome these points. They can be easily machined, can be made much harder than manganese steel, and when scrapped can be used for other purposes.

After a great deal of experimenting and research covering a great many combinations of alloys, it has been found that steels containing chromium, nickel, and vanadium offered the most feasible and versatile products for the different classes of work covered. Some castings contain only nickel, some only chromium, some varying combinations of nickel and chromium, and some consist of different amounts of all three elements. Carbon contents are made suitable to the exact use of the casting.

The Melting Practice.

All are cast from basic electric furnace, as are the Company's other products, grey iron and "Duroloid," an alloy white iron for abrasive resisting work. The furnace is a standard 2-ton Greene type, lined to the slag line with magnesite, and similar in detail to any basic furnace. A skim gate is used and a tea-pot ladle for pouring.

Moulding and Heat Treating.

Great care must be used in the core making and moulding for this class of work. Due to its heavy duty there must be no interior flaws such as small shrink cavities or blow holes, and as a result larger heads and different gating must be employed than would be used on ordinary steel casting work. This results in a smaller yield of cleaned castings from metal poured, but in a true quality product.

The heat-treating equipment is all standard, the ovens being both gas and oil connected. For quenching, standard oil and water baths are used. All temperature checking is done by means of pyrometers and each class of steel has been accurately checked for critical points, so it becomes an easy matter to keep the castings at the temperature desired.

Nickel Steel Alloy Castings.

Nickel has the same effect upon steel as carbon, although to a greater degree, that of lowering the transformation points. For the ordinary grades of nickel steel used in the above casting work, those of from 1.00 per cent. nickel up to 4.00 per cent. nickel, it is found that 0.50 per cent. nickel will lower the Ac_1 range about 5 deg. C. and the Ar_1 on cooling about 10 deg C., from those of similar contents in plain steels.

Nickel steels offer a distinct difference from plain carbon steels when heated above the critical points for any length of time, carbon steel tending to grow in grain size while nickel steels tend to become finer and closer in grain. This is an advantage in handling a large piece of work because the time of soaking may be prolonged and at the same time the grain refining becomes superior. This, of course, raises the cost of treating, but in a strict quality product this is of secondary importance.

Treatment of Small Castings.

On small-size castings the general practice is to heat above the upper critical range, allow to soak until the heat is even throughout the piece of work being treated, withdraw from the furnace and either oil or water quench. These pieces are then drawn back to the temperature necessary to give the toughness required. On larger-sized castings it is often necessary to give a double quench in order that the transformation may be complete, nickel having the tendency to retard this action.

Table I.—*Tests from 1.5 per Cent. Nickel Steel.*

	Tensile strength, tons per sq. in.	Elastic Limit, tons per sq. in.	Elongation, per cent.	Reduction of area, per cent.
As cast	34.3	19.2	24.0	32.6
Annealed from 815 deg., cooling in furnace	35.5	23.3	26.2	41.9
Air cooled using strong air blast from 815 deg., drawing back to 480 deg. ..	36.6	25.4	27.8	44.6
Oil quenched from 815 deg. ..	50.0	43.7	19.0	37.0

A bearing casting was cast from metal analysing carbon, 0.23 per cent.; manganese, 0.75 per cent.; silicon, 0.21 per cent.; nickel, 1.53 per cent.; phosphorus, 0.035 per cent., and sulphur, 0.02 per cent. Table I. gives a comparison of the different results which may be obtained by varying the treatments.

Some tests upon nickel steel averaging carbon, 0.25 to 0.30 per cent.; manganese, 0.60 to 0.70 per cent.; silicon, 0.20 to 0.25 per cent.; nickel, 3.25 to 3.50 per cent.; sulphur, 0.01 to 0.04 per cent.; and phosphorus, 0.01 to 0.04 per cent. are given in Table II.

Brinell hardness numbers will range from about 175 on the annealed specimen to 400 on some of the more drastic quenches.

Chromium Steel Alloy Castings.

Chromium acts in a similar manner to nickel in changing the critical points of steels, but in the opposite direction, causing these temperatures to become slightly higher than those of plain steels of

Table II.—*Properties of Cast 3.5 Nickel Steel.*

	Tensile strength, tons per sq. in.	Elastic limit, tons per sq. in.	Elongation, per cent.	Reduction of area, per cent.
As cast	47.8	20.5	20.0	48.0
Annealed from 785 deg.	37.2	19.5	24.4	53.2
Quenched in water from 760 deg., drawn back to 480 deg.	41.5	33.2	20.7	66.4
	45.8	36.2	19.8	71.7
Quenched in water from 760 deg., drawn back to 275 deg.	61.0	50.8	13.4	58.8
	64.0	27.2	12.9	55.7

the same carbon contents. Chromium is exactly the opposite of nickel in regard to the effects of overheating for prolonged periods, rapidly deteriorating in strength and resistance to shock. For this reason a double quench gives superior qualities to these classes of steels. Chromium steels are capable of taking great hardness without a corresponding decrease of toughness, which makes them desirable for any such purpose as crusher jaws, wearing plates and similar uses. As this hardness comes directly from the double carbide of iron and chromium the steel must be softened according to the amount of machining to be done. The general treatment on this class of steels is similar to that on nickel steels—quench from above the critical point, either draw back in

air, or re-heat and re-quench at the lower temperature. Their properties are about as set out in Table III.:—

Table III.—*Properties of Cast Chrome Steel.*

	Tensile strength, tons per sq. in.	Elastic limit, tons per sq. in.	Elongation, per cent.	Reduction of area, per cent.
Analysis: Carbon, 0.60 to 0.70 per cent.; chromium, 0.50 to 0.75 per cent.				
Quenched at 815 deg., drawn back to 705 deg. ..	35.5	28.7	34.4	66.6
Drawn back to 565 deg.	22.9	42.0	20.1	60.0
Drawn back to 800 deg.	50.9	46.0	14.3	54.4

Nickel-Chromium Steel Alloy Castings.

This class of steel probably represents the best general type of steel for heat-treated castings. The steel, when treated, shows the beneficial result of the toughness and ductility of the nickel together with the increased hardness and cohesion of the chromium. The best results are obtained by having a certain ratio of the two metals, usually about 2.50 per cent. nickel to 1.00 per cent. chromium. The general method of treating is to quench in oil from a temperature higher than the critical point and draw back to the temper desired. For very high specifications a double quench is used.

Table IV.—*Test results on Cast nickel-chrome steel.*

	Tensile Strength, tons per sq. in.	Elastic Limit, tons per sq. in.	Elongation, per cent.	Reduction of area, per cent.
Analysis: Carbon, 0.30 to 0.40 per cent.; chromium, 0.50 to 0.70 per cent.; nickel, 1.30 to 1.70 per cent.				
Annealed from 815 deg.	29.7	16.6	17.5	54.3
Annealed from 730 deg.	29.0	14.6	30.1	25.8
Quenched from 815deg., drawn to 535 deg. ..	40.2	29.0	23.9	61.6
Quenched from 840deg., drawn to 460 deg. ..	37.7	22.3	26.5	57.7

Quench from about 10 deg. C. above the critical point, re-quench from just above the critical point, and then draw back. Their properties are about as tabulated above.

The results shown in Table IV. go to show in a general manner what can be accomplished along these lines, but are by no means put forward as a text or as the absolute figures which can be obtained. There are many times where castings poured from the same heat and treated in the same manner will show widely differing results. We attempt to explain this by a difference in structure caused by such points as a different temperature when poured, different texture and temperature of the mould, etc., but, as we have no microscopical test laboratory, we are undecided at this time. These points will be proven later when we have absolutely determined, through wider use, the true value of the product as shown by its ability, not to fulfil tests or laboratory specifications, but in the test under actual working conditions.

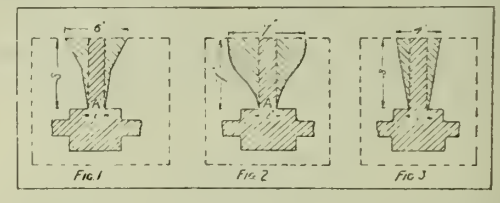
At the invitation of Ferranti, Limited of Hollinwood, a number of visitors were recently enabled to inspect the work upon the step-up transformers which are being supplied by the firm to the order of the New Zealand Government. The transformers are for use at the hydro-electric station at Mangahao, where power is generated at 11,000 volts. Each transformer group steps up this pressure from 11 000 to 110,000 volts, three-phase, for overhead line transmission. Another feature in the works which attracted attention was the exhibition of the newly-patented Dawson Ferranti non magnetic cast-iron.

Riser Shapes.

In spite of the evidence put forward in favour of making castings without risers, practical foundrymen generally still believe in the efficacy of the riser. Further, the most advanced no-riser votaries do not contend that risers are unnecessary in all cases. Their utility admitted, it is, however, undeniable that risers are often wrongly shaped. This is clearly shown in an article by "J. A. N." in the August issue of *La Fonderie Moderne*, of which the following is an extract:—

Many moulders fail to realise the true function of the riser. As a consequence, it is often incorrectly shaped. This is especially the case where its height is unduly limited by the use of a too shallow cope. With the idea of increasing the pressure, they increase the top diameter of the riser, whilst maintaining the same height. Some even go so far as to reduce the height, in the belief that such reduction is compensated for by the increased diameter. The riser then most frequently assumes one of the shapes shown in Figs. 1 and 2.

Now there is a law in physics which states that "the pressure exerted by a liquid upon a horizontal surface is equal to the weight of a column of that liquid having for its base the surface under pressure and for its height the distance from this surface to the top of the liquid."



From this law it is clear that, since the height of the riser remains the same, the increased top diameter does not increase the pressure in the slightest degree. On the other hand, there is a considerable loss of metal. Furthermore, the riser, supported too completely by the sand, is not so effective. Finally, as the metal contracts, the riser draws from the casting; consequently there is a great danger of cavities being formed at A.

According to the principle above referred to, it would appear that the riser should be formed like a cylinder. This would, of course, be correct if we had only pressure to consider. But the riser has other uses. It serves as a reservoir of heat. For this reason it should be given a slightly cone-shaped form, as shown in Fig. 3. Here, whilst the pressure with the 4-in. top dia. is equal to that shown in Fig. 2, where the dia. is 7 in. at the top, the loss of metal is considerably reduced. Moreover, the troubles referred to above are eliminated.

It should be noted that the dimensions given on the sketches are used merely for illustration purposes. In practice, in order to arrive at these dimensions, it is necessary to take into consideration the size of the casting, so that the riser may give both the pressure required and an adequate supply of heat.

The Manufacture of 30-in. Flexible-Joint Cast-Iron Pipes.*

The pipes have a length of 12 ft. in work and of 13 ft. 1 in. overall and are 1.37 in. thick. The joint used is a modified Ward joint. The spigot end is machined to gauge to a radius of 18¼ in., and on it a shoulder is cast integrally with sufficient projection to provide a definite stop at maximum deflection which will not injure the lead joint. The socket has an interior ring which serves to hold the lead and to centre the pipe, and an external steel band, 4 in. by 1 in., is shrunk on to protect the socket in transit. The author describes the pattern and core equipment and the operations of casting and machining the pipes. — W. G. Hammerstom. (*Eng.* N.-R. 88, 780.)

* Institution of Civil Engineers, Abstract.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

The opening meeting of the session was held at the Cutlers' Hall on October 20. The President, Mr. T. Swinden, D.Met., was in the chair, and there was a representative attendance

PRESIDENTIAL ADDRESS.

Dr. Swinden, in giving the presidential address, said:—Gentlemen, my first duty is to tender my sincere thanks for the honour you have done me in electing me your President. As my present duties are not directly connected with foundry work proper, I can only conclude that your action has been prompted largely by an appreciation of some little pioneer work which I greatly enjoyed doing in the early history of the Sheffield Branch fifteen years ago. I willingly confess that the chief factor which decided me in accepting your generous compliment was the fact that in Mr. Macdonald the Branch has an ideal secretary, and everyone knows the utmost importance which attaches to this post so far as the welfare of the Branch is concerned. You may rest assured that I will do all I can to further the welfare of the Branch with Mr. Macdonald's co-operation.

Status of the Sheffield Branch.

Now as to the status of the Sheffield Branch in the Institution. The total number of members is 196, constituted as follows:—Members, 85; associated members, 96; associates, 15; and subscribing firms, 6, out of a total number in the Institution of 1,505. It ranked fourth in numbers amongst the nine branches, being exceeded by the Scottish (281), Lancashire (227), and Newcastle (223) Branches.

There is no doubt that a determined effort on the part of individual members to interest others in our work and swell the numbers is urgently needed if we in Sheffield are to maintain and improve our position. The Institution of British Foundrymen is now the recognised authority in matters pertaining to foundry practice so far as this country is concerned, and it is our duty to see that the dignity conferred by the Charter is upheld. Our activities are an index to the world of the extent to which the problems of the foundry are being tackled in this country. The success of the Institution depends absolutely upon the energy and enthusiasm of its Branches, and it is for us in Sheffield to at least carry our weight.

Sheffield Foundry Trade Technical Society.

You will no doubt expect me to say something of the newly formed Foundry Trade Technical Society in Sheffield. I candidly admit that my first thoughts were in the nature of a disappointment that it should have been considered necessary to form such a Society, but on reflection one's views are modified. The disappointment arose, of course, from the fact that we have a class of membership (associates) designed expressly for the benefit of what we will call, with all respect, artisans, and we have each year directed at least a portion of our activities in a manner intended specially to appeal to such men. We must remember, however, that if our work were to be confined wholly or even principally to an explanation of the elementary principles of foundry work, we should, in my opinion, fall far short of our duty, and it must be noted that the associates only comprise 7½ per cent. of our membership. The object of the new Society, as I understand it, is to create an *interest* in the principles of foundry work. I say "interest" advisedly. I cannot hope in a short course of lectures spread over several months to *teach* even the essential principles, but if the foundry worker will attend these lectures, he will be encouraged to think and to see that, after all, there is a "reason why" in the daily operations in the foundry, and will no doubt gain information in shop language on current problems. One can imagine that the result may possibly be the formation of a series of classes expressly for foundrymen, where principles could be taught; and certainly the hoped-for result is that we, the premier technical body of foundry workers, would find our membership swelled by a body of men eager to discuss the latest advances in their craft and capable of readily understanding the data put before them. I therefore welcome the Technical Society, and wish it every success.

The Object of the Institution.

I referred just now to our "duty." What is the duty of the Institution? The definition in our articles is "to promote the intellectual welfare of our members," and, further, we have our motto, "Science hand-in-hand with labour." In effect, therefore, the avowed object is to encourage an appreciation of science in the foundry.

It has recently been pointed out that the Institution was founded by *practical* foundrymen. I saw something of that original enthusiasm, and its memory will always be a source of inspiration to me. The wonderful Freemasonry, the obvious pleasure in discussing each other's difficulties, and the good-fellowship evidenced at those meetings was a real pleasure, and was the foundation on which this great Institution has been erected. We have recently been told, however, by one of the founders, that the object was "to try to teach the academic gentleman." Of course, I have no *locus standi* to question this, but I must admit that I had never before visualised our motto in quite this sense. However, we will let that pass.

Scientific Control.

The question is: Do we or do we not believe that the daily operations in the foundry are controllable according to scientific laws? The difficulties may be great, and the results under certain sets of conditions may appear not to justify the belief, but surely everyone agrees that the combustion of coke or gas, the melting of metals, the reactions between the constituents, the physical behaviour of metal during melting, casting and cooling, and so on, are governed by certain laws which, for the want of a better word, we may group under the general term "science." If so, it surely follows that research work, even of a purely academic character, having for its object the elucidation of certain laws and their application as concerning this branch of science, if sound and reliable, is of the utmost value. The reply may be: "Yes, but don't bother us with it until its clear value and application to our particular job is demonstrated. Let the purely academic work be reported separately, and, in effect, let the academicians amuse themselves with it as long as they like, but leave us alone with our practical problems." One appreciates that view up to a point, but how often does one see earnest, hard-thinking, practical men, well trained and skilled in their business, grappling with serious problems—largely by methods of trial and error—meeting with repeated disappointments and set-backs, largely through an imperfect knowledge of the scientific principles governing the behaviour of their produce, or lacking the determination of some factor which can only be revealed by careful research, for which they have neither the time, facilities, nor training. We agree at once that the converse is by no means unknown. The scientifically trained man, inexperienced in the broader practical aspect, may endeavour to lay down a procedure according to the results of a research, which the practical man can at once condemn as impracticable, if nothing worse. What can we do, then, to achieve a reasonable realisation of science walking hand-in-hand with labour?

Education of the Worker.

I suggest, firstly, that the working man must be encouraged *to think*. The day when it was thought to be fatal to encourage what is termed "unskilled" labour to think is gone. The problem to-day is how to encourage unskilled labour to thing intelligently about their daily work. There will always be a class of man to whom this will not appeal in the slightest, but it will at any rate give a greater interest to a by no means small proportion of men who are unquestionably anxious to have a better understanding of their work.

Then, secondly, foremen, managers, and employers who, one assumes, have the desired prac-

tical experience, and have shown the desire to learn, should be encouraged to read and to attend meetings, lectures and classes—with what object? Here is my main point. Not in a carping spirit to pick holes in everything that does not precisely conform to their idea of the right way of doing things, but to be on the lookout always for a guiding principle and a practical hint. There may be lectures of a more or less academic character which frankly they do not pretend to understand.

Criticism of Lectures.

I would suggest that in such cases the most important thing is to endeavour to look at the problem from the point of view of the lecturer. If the work is well done, even the practical details of the experiments will be interesting, and probably of direct suggestive value. The results should be considered with an unbiassed mind and noted with a view to their application as and when opportunity offers. The conclusions or hypotheses based on the results should be critically examined in the light of one's own experience and the work of other investigators in the same field.

It is unnecessary, I feel sure, to quote examples, because there must be heaps in the mind of every man present, of work which appeared to be purely academic and abstruse when first presented, which to-day is universally recognised as of *fundamental*, practical importance, and the application of which has solved what would be termed eminently practical problems. I urge, therefore, that we do not decry scientific work, even of the scientific character, and drive it away from our Institution and proceedings. Our support of the Cast Iron Research Association is illogical, to say the least of it, unless we really do mean that we want science in the foundry, and that our motto is not an idle catch-word. The proceedings of the Association may be couched in practical terms, and the whole of the *experimental* details may not interest foundrymen, but rest assured that if the really abstruse problems which are behind many of the daily troubles are to be solved, a very great deal of arduous and purely academic work will have preceded the practical advice which we all trust will mature from the B.C.I.R.A.

I make no apology for this rather lengthy reference to this somewhat hackneyed subject of the application of science to industry. It is one of the canons of our faith, and whilst I hope it is unnecessary for many of those present, I feel that there is always a class of men who definitely distrust and show apathy, if not antipathy, towards the scientific aspect of their craft.

Research and the Craftsman.

Looking now on the broader aspect, it cannot have failed to have been noticed by all thinking men that in referring to any industry it is still quite a common thing to see references to industry as being built up by capital and labour. Now I do not wish in any way to transgress the rules of the Institution which forbids discussion of matters relating to what may be termed labour questions. That is not my object.

But consider for a moment an industry operating on dead capital and uninterested labour. Such concerns are not entirely unknown, and their fate is assured. By dead capital I mean money invested by people not interested at all in the detail of the plant or processes concerned, but simply desirous of a reasonable return as a means of livelihood. We may assume that they are kind, humane, reasonable people. And, on the other hand, picture labour, if you can, with no ambition or interest or desire to improve on the daily work which provides them with their means of livelihood. The type referred to by Mr. James J. Davis, Secretary of Labour in the States, who recently told the story of a workman approached by an exasperated foreman with the reprimand:—

"Here, John, what's the matter? Don't you see that the man besides you is doing three times as much work as you are?"

"I know," was the reply; "I've spoken to him about it half a dozen times, but he doesn't pay any attention to me."

The result, we all know, would be ultimate disaster. What, then, is missing? What is the leaven which changes these conditions into one of life and vigour and prosperity in the world's work? For the want of a better word, let us call it enterprise. In this general term I embody commercial, practical, technical and scientific acumen. It is just that something which is always striving to improve, to develop—to perfect the daily task. It brings satisfaction to the individual and life to the industry.

Metallurgical Enterprise.

Some of you may have read R. E. Leader's "Sheffield in the Eighteenth Century." Leader tells many interesting stories of early enterprise in the development of this city, from which I venture to repeat the following:—

"The Harrisons, of Hollis Croft, were early saw manufacturers. The fame of their house, and the fortune which was afterwards manifest at Weston Hall and in the large benefactions of the Misses Harrison, began in this wise:—

> "Thomas Harrison took with him to London a workman named Elick Rutter. Him he sent, dressed like a carpenter, and in his shirt sleeves, apparently fresh from his work bench, among the London shops, asking for 'Harrison's saws." None of the shopkeepers had ever heard of such a maker. They had, of course, saws by this eminent firm and the other which they recommended to the customer, but he would have none of them, declaring that no saws were like Harrison's, and theirs he must have. This, from an actual user of tools, made its due impression, and a few days afterwards, when Mr. Harrison happened to call soliciting orders, he found no difficulty in obtaining them. This story is authentic, since it comes from an old workman of Harrison's, who knew Rutter well."

The bearing is perhaps more commercial than technical or scientific, but it will serve to illustrate my point.

Now I do not wish to suggest for one moment that the foundry industry is without enterprise. That would be absurd. But, nevertheless, the references to the foundry as being the Cinderella of the engineering industry do keep cropping up in a very disconcerting way. Some may blame one thing and some another, but my object to-night is to suggest that at least one way of removing the stigma is to regard technical or scientific work as an essential and desirable thing. Endeavour to tackle the problems which are your daily work in an orderly and, if I dare say it, scientific way, and, above all, if you are asked to co-operate with a technical man, do so in a generous and helpful way. If he is the right sort of man (and there are plenty) he is not out to steal your job or make you look small. The main duty of a technical man in a works is to relieve the managing staff (and through them the workmen) of some of the worry and troubles which arise through our imperfect knowledge, and although occasionally there are lamentable exceptions, I believe that, speaking generally, the technical man realises this as his duty. It is not the least bit clever of a practical man to trick or mislead his technical colleague by what he would call a trick of the trade. And yet it is done, even by men who are otherwise perfectly honest and sincere, under the misguided notion that he would otherwise be giving away his "trade." The same practical man is no doubt desperately anxious to serve his employer and to avoid wasters, but he lacks faith in anything that does not appeal strictly to his preconceived practical ideas as to what can be done, and in many cases he causes himself a great deal of avoidable worry. It is far wiser to spend time and money on scientific research judicially applied than on *post mortems*.

Position of Foreign Research Work.

I, therefore, appeal to you to do all in your power to interest your friends in the work of the Institution, of the Cast Iron Research Association, and of kindred societies, all of which have one object, and one object only, which is to remove the sources of trouble, to improve the produce so as to develop the scope of the industry, and to put and keep the foundry in the forefront of the industries of this country and of the world.

You may rest assured that if we fail to do this we shall undoubtedly recede in our international status. Note the attitude of the American Federation of Labour as evidenced by a manifesto recently issued.

After outlining their reasons, it was:—

> "Resolved, by the American Federation of Labour in convention assembled, that a broad programme of scientific and technical research is of major importance to the national welfare, and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended."

And this, in spite of the fact that they have already *established homes of research far greater than anything we have in this country.* Of scientific research in Germany, France and Sweden, all State-aided, you are no doubt fully aware, but you may not all be conversant with the enormous strides made in Japan. We are told that in 1917 the Japanese Government was empowered to grant a sum exceeding £200,000, payable in instalments over a period of ten years, to establish a laboratory for scientific and industrial research at Tokyo, and through further donations a sum considerably exceeding half a million sterling is available. The work is at present being carried out in the Universities of Tokyo, Kyoto and Sendai, and an indication of the progress made is evidenced in the fact that in May last the Bessemer Medal of the Iron and Steel Institute was presented to Prof. Honda, of Sendai, for original research in metallurgy.

Those who know anything of business in Japan will have a good idea of the extent to which scientific training, largely acquired in this country, on the Continent and in America, has been assimilated and applied to the industries in Japan.

I wish, therefore, in conclusion to make an earnest appeal on behalf of the Cast Iron Research Association. Brush aside the petty jealousies and narrow prejudices, and give the scheme your earnest support; and finally to make a special effort to maintain the fair name of Sheffield in your National Institution by supporting the work of the Branch.

Votes of Thanks.

Mr. J. Shaw proposed a hearty vote of thanks to Dr. Swinden for his highly interesting and instructive address. He certainly did not think there was a great deal of feeling against technical men. If progress had to be made, that feeling of sympathy which had been referred to must be there. The address had been most excellent and illuminating.

Commander Jackson, in seconding the vote, said it had been quite a treat to listen to the address. Speaking personally, he had always found the men in the foundry very willing to receive any information they could give them from the scientific side. There was no doubt that research played a most important part in their business.

The resolution was carried with acclamation.

The Secretary (Mr. Macdonald) referred to the fact that a member (Mr. H. Lewin) who went out to India from this district now filled an important position, and not many years ago he was an ordinary journeyman. Amongst other things he went in for a competition which The Foundry Trade Journal threw open, and was awarded a twenty-two guinea prize. This showed whether one could get any benefit from the Institution; at all events, he obtained this important position for himself.

The President, in reply, expressed his appreciation of the vote, and said he fully recognised what Mr. Shaw had said. It was not the object of the technical man to try to boycott the practical man. If a man set out to investigate a problem, and did his best in a really careful and scientific way, he should be encouraged. By way of example: Anyone undertaking a research to determine the conditions under which gas existed in iron and steel would do a great service, and although this would be purely scientific research, it would obviously have an extremely important bearing on urgent practical problems of to-day.

SCOTTISH BRANCH.

At the second meeting of the session, held at the Glasgow Technical College, on November 4, Mr. H. M. Hodgert, Branch President, in the chair, Mr. J. Wilson (Falkirk) introduced a discussion on "Cupola Practice."

CUPOLA PRACTICE.

Mr. Wilson, at the outset, stated that the cupola consisted of a cylinder of boiler plates lined with fire bricks, with suitable arrangements for the admission of air and with an opening in the shaft for charging the cupola with coke and iron, provision also being made for the removal of slag and for tapping the molten metal, the size of the furnace being regulated by the amount of metal to be melted per hour.

The lecturer suggested that the tapping hole should be slightly higher than the level of the bottom, in order to keep the bottom hot.

The wind-box or air-chamber consisted of a steel belt attached to and surrounding the cupola at its lower extremity, for the purpose of distributing the blast uniformly in pressure and volume through all the tuyeres.

Mr. Wilson stated that the tuyeres were by far the most important part of a cupola, as the melting was in a large measure controlled by the size, position, and shape of the tuyeres.

The function of the tuyeres was to distribute the air to the fuel and, in order to perform this function correctly, the area of tuyeres should bear some relation to the cross-sectional area of the cupola at the melting zone.

Tuyere Ratio.

In smaller-sized cupolas the ratio is 1 to 5, that is, the combined area of the tuyeres is one-fifth of the cross-sectional area of the cupola at the melting zone, while in large cupolas the ratio is 1 to 10, the area of the tuyeres for the intermediate sizes of cupolas varying in proportion.

In the smaller cupolas the air does not require to go very far in order to reach the centre of the cupola, whereas, in large cupolas, the air has further to travel, and, with the reduced tuyere area, the velocity of the air is increased, thus enabling it to penetrate to the centre of the cupola.

Many different types of tuyeres have been tried, each claiming some particular advantage over the other as regards distribution of blast and increased melting efficiency, but in actual practice they have not shown any appreciable difference from the results obtained from the ordinary straight tuyere.

The factor which regulates the shape of the tuyeres is as follows:—As the contact point of the tuyere and fuel bed is the governing factor, it is necessary that, from this point backwards to the air belt, the tuyere should be enlarged so that the loss of power through undue friction may be avoided. The point of the tuyere in contact with the fuel should be rectangular in shape and only a few inches high, but fairly wide. To ascertain the reason why it is desirable to have the tuyere low and wide, and not high and narrow, it is necessary to study the theory of fuel combustion.

Fuel Combustion.

Carbon, when it is burned completely in an excess of air, generates carbon dioxide (CO_2), or more familiarly known as carbonic acid gas, but when an insufficient quantity of air is supplied to the carbon, a vastly different gas is formed, known as carbon monoxide (CO). The effect of these two gases is as follows:—When carbon burns to CO_2 the maximum amount of heat which can be obtained from the fuel is obtained, whereas, when CO is formed, only about one-third of the possible heat is evolved. If these results are put down in figures, the comparison will be more obvious.

One pound of pure carbon burned to CO_2 generates 14,500 units of heat, whereas the same amount of carbon burned to CO generates only 5,000 units of heat.

It should be noted that the gas in the form of CO is capable of being burned further, but unfortunately, when this gas is formed in the cupola, the heat cannot be recovered from it at the point where it would be most useful, namely, at the melting zone.

Carbon burned to carbon dioxide takes up a definite proportion of oxygen from the air, namely, for every 12 pounds of carbon burned to CO_2 32 pounds of oxygen are used, whereas, when the carbon is burned to carbon monoxide, for every 12 pounds of carbon burned only 16 pounds of oxygen are used. Carbon monoxide gas may be formed in two ways, namely, by burning carbon with an insufficient supply of air and also by the action of CO_2 on red-hot carbon.

It will be observed that carbon can unite with oxygen in two different proportions, namely, 12 to 32 and 12 to 16; in burning to CO_2 it takes double the amount of oxygen than it takes when the carbon is only burned to CO. It is now reasonable to state that CO_2 can be made to part with the extra amount of oxygen it has taken up, and this does happen when CO_2 is passed through red-hot carbon; therefore, two parts of CO are formed in place of the original one part of CO_2. Referring back to the question of the height of the tuyeres, and considering a tuyere 12 in. high which is admitting air to a fuel bed, the height of which is 24 in. above the top of the tuyeres. The air from the middle of the tuyere has, therefore, to travel through 30 in. of coke, and on travelling that distance has united—or rather the oxygen of the air has united—with carbon forming CO_2, thus giving its maximum of heat.

The air from the bottom of the tuyere is doing the same thing, and all the oxygen of the air has been converted to CO_2 on travelling through a height of 30 in. from the bottom of the tuyere, but this CO_2 formed with the air from the bottom of the tuyere has still to travel some distance through the fuel bed, which is now incandescent. Thus, the CO_2 is now in contact with red-hot coke, and may form CO. This is very likely to take place with the CO_2 formed at the lower part of the tuyere, thus preventing the maximum of heat generating from the fuel.

The lecturer made some observations on the question of cupolas having more than one row of tuyeres; from the arguments which he had just stated, he favoured one row of tuyeres only.

The whole question of efficient cupola practice is to get the maximum amount of CO_2 formed, thus ensuring that the maximum of heat is being extracted from the fuel.

In practice it is impossible to get the whole of the carbon converted to carbon dioxide, but it should be the aim of every foundryman to get as near the maximum as possible.

Fans and Blowers.

Many different types of fans and blowers have been placed on the market, each claiming to have some particular advantage over the other; the only thing necessary, however, is to get a machine which will supply a definite amount of air into the cupola within a stated time.

The lecturer favoured the positive blower for the following reasons:—If a fan is used, it will probably work efficiently under ideal conditions, but if anything unforseen happens in the cupola and the tuyeres become stopped, the fan becomes practically useless for supplying air, and the cupola man wonders why the iron is not melting, because his air supply appears to be sufficient according to the pressure gauge. The pressure recorded on the gauge is only the resistance of the cupola charges to the air, and is not a true record that air is being supplied to the cupola at the pressure indicated.

With a positive blower, the conditions are entirely different, in so far that the cupola must take the air supplied, and, if a slight stoppage takes place, the air enters the cupola at a higher pressure, which will be recorded on the pressure gauge.

In some installations where a positive blower is used, a safety valve is fixed on the blast main so that, if any serious stoppage takes place, there is no danger of bursting the blast main or the wind box.

Blast Pressure and Volume.

Formerly, great faith was put on the pressure of the blast, and 16 ounces was given as the figure which should not be exceeded.

Certainly, where the cupola is in good working order, this figure should be a maximum, but where there is a tendency for the cupola to choke—and this is quite possible when inferior coke is being used—the pressure must of necessity rise if the fuel has to get sufficient air for its combustion. The pressure gauge is no guide in itself, and it matters little whether the pressure gauge is recording 5 ozs. or 5 lbs., so long as a sufficient volume of air is being supplied. What is required on all cupola installations is an instrument which will measure the volume of the air that is being admitted to the cupola.

To get the best results, a sufficient volume of air must be introduced to burn the carbon to CO_2, or at least to have a preponderance of this gas, and this can only be assured if there is some means of determining the amount of air passing into the cupola. For every pound of carbon burned to CO_2 takes 142 cub. ft. of air, or for every pound of coke, which is an impure carbon, the air required will be from 125 to 130 cub. ft. of air.

These figures for air will vary somewhat on the weather conditions; on a warm day more air would be required, as the air will not contain quite so much oxygen per cub. ft. as it does on a cold, dry day.

Oxygen in Iron.

The figures which have been given for the air supply are calculated from what might be termed a theoretical basis; in actual practice, however, they should not be greatly exceeded; otherwise there is a danger of spoiling the metal in the cupola.

It is quite evident from the very nature of the melting process that the metal is in direct contact with the fuel, and it would be foolish to have any appreciable free air or oxygen coming in contact with the metal at the melting zone. If free oxygen should be present, the possibility is that it will combine with the iron, forming iron oxide, and this compound, when formed in cast iron, has a very far-reaching effect.

The lecturer stated that, in his opinion, the presence of this compound in iron was responsible for more bad castings than all the other causes which are usually blamed for the various troubles met with in the foundry.

Charging the Cupola.

The cupola, after it has been kindled, is ready to receive the bed charge; the amount of coke in the bed varies with the size of the cupola.

The bed charge must extend above the melting zone of the cupola, and, as the first charge of iron has to be melted by this coke, it is obvious that the zone of most active combustion must be filled by coke. Owing to the variation in the weight of different cokes, the amount of coke in the bed charge should be measured in preference to weighing.

When small quantities of metal are being dealt with in the cupola the amount of the bed charge seriously affects the ratio of coke per ton of iron melted.

The top of the coke bed should be as level as possible, on the top of which is placed the first charge of iron; this is followed by a quantity of limestone or other fluxing material. When charging, the pig-iron is spread on the top of the coke, and on the top of the pig-iron is placed the scrap.

If it is desired to add steel scrap, the steel is placed on the top of the pig-iron.

To arrive at a standard charge, a good plan is to build a ring of coke 4 in. high, the same diameter as the cupola; this is then weighed, and a quantity of metal is determined bearing a direct ratio to the weight of the coke.

This ratio is usually about 10 parts of metal to 1 part of coke; this ratio may vary according to the quality of the coke used and the brands of iron being melted, and also on the efficiency of the cupola. Consideration of the working conditions of the cupola will show that, with the usual arrangement, the most rapid and economical melting will result if each charge of iron were contained in a shallow basin of coke in which both bottom and sides were of equal thickness.

The one condition necessary for the best working is that the blast shall always blow on coke and that the heat shall be taken up by the iron.

If the layers of coke are quite regular and the blast blows across them, each layer of coke must be capable of melting the iron charge resting on it. Any excess of coke will gradually accumulate

and keep the iron higher up, thus reducing the rate of melting, whereas, any deficiency of coke will lead to the iron getting in front of the tuyeres, and cold and bad metal will result.

With iron and coke, however, in proper ratio and in equal layers in the cupola, the iron charge melts as it descends, and coke is always maintained in front of the tuyeres.

In practice, the arrangement of fuel and iron just described is not easily obtained, but it can be approximated by throwing the iron of the charge more to the centre and keeping the coke more towards the sides, taking care, however, that the coke completely covers the charge below it and also forms a supporting bed for the next charge of metal; there must, however, be no central column of metal merely surrounded by coke, or *vice versa*.

Melting Different Charges.

In foundries where the class of work is uniform, or where the volume of work is sufficient to use separate cupolas for different purposes, the charges fixed upon can be repeated until the work is completed. In smaller foundries, however, where a single cupola has to do all the melting, it is often necessary to melt different mixtures during the same run. Therefore, when a change of mixture is being melted during the same run, a good arrangement is to divide the two different mixtures by a slightly thicker layer of coke.

This has the effect of slowing down the melting temporarily, due to the burning of the extra coke, and a much sharper division of mixture can thus be obtained.

A considerable amount of discussion took place after the lecture, and at the close of the meeting Mr. Hodgert proposed a vote of thanks to Mr. Wilson for his most interesting and instructive address, and this was heartily responded to by the members.

Analyses of Iron and Steel.

Mr. Paul V. Kline, in a recent issue of "Iron Trade Review," recommends the following methods for the determination of phosphorus and manganese in iron and steel, as being short and accurate.

The formation of the pure ammonium phosphomolybdate with a constant composition is possible only under certain closely-controlled conditions. It is necessary, therefore, for the chemist to ascertain for himself by repeated experiments what these conditions are and to standardise the solutions and make the determinations under exactly the same conditions each time.

Weigh 1 gramme of finely-divided drillings and transfer them to a suitable 100 cub. cm. flask, and add about 50 cub. cm. of dilute nitric (323 cub. cm. of nitric to 1,677 cub. cm. of water). Set the flask on the hot plate and heat until the drillings are in solution and the brown fumes expelled. Set the flask aside or cool under the tap down to room temperature. Then carefully dilute to mark and filter through a dry filter. Now pipette off 50 cub. cm. of the filtrate into a 300 cub. cm. flask. This will represent 0.5 gramme of the sample to be used for the phosphorus determination. Next pipette off 25 cub. cm. of the filtrate into a 200 cub. cm. beaker to be used for the manganese determination. This, of course, represents 0.25 gramme of the sample.

Phosphorus.—Set the flask containing the 50 cub. cm. sample on the hot plate and allow the solution to come to a boil. Then add enough potassium permanganate solution (10 grammes of potassium permanganate per 100 cub. cm. of water) until a chocolate precipitate is formed. It usually takes about 2 cub. cm. of the permanganate solution to do this. Now destroy the brownish precipitate with a ferrous sulphate solution (50 grammes of ferrous sulphate in 500 cub. cm. of water and a few drops of sulphuric acid). A few drops of this solution is all that is necessary and gives the solution in the flask a greenish cast.

Bring the solution to the temperature of the hand, and add 15 to 20 cub. cm. of ammonium-molybdate solution (130 grammes of molybdic acid thoroughly mixed with 284 cub. cm. of distilled water and 286 cub. cm. of ammonium hydroxide, specific gravity 0.90, added when solution is complete. This is poured with constant stirring into a mixture of 670 cub. cm. of nitric acid and 760 cub. cm. of water. Shake vigorously to bring down the yellow precipitate. Allow the yellow precipitate to settle only a few minutes; otherwise it will stick to the sides of the flask, making it difficult to wash on to the filter paper.

Carefully filter and wash with 1 per cent. potassium-nitrate solution until the flask and paper are free of acid. Transfer the paper into the original 300 cub. cm. flask, add 25 cub. cm. of water, and a few drops of phenolphtalene indicator and a measured excess of N/10 sodium-hydroxide solution. Insert the stopper and shake vigorously until the yellow precipitate is dissolved; remove the stopper and wash the stopper and sides of the flask with distilled water. Titrate with N/10 nitric acid. Titrate the acid and the alkali against each other, and also against a standard sample.

The calculation of results is as follows:—W = Weight of phosphorus in 0.5 gramme of standard sample used. A = The cub. cm. of alkali used. B = The cub. cm. of acid used to back the titrate. R = The ratio between the alkali and acid in cub. cm. as found by titrating one against the other. Then amount of phosphorus per cub. cm. of N/10 alkali $= \frac{W}{A - B \times R}$

Amount of phosphorus in any sample $= (A - B \times R) \times$ (amount of phosphorus per cub. cm. N/10 alkali) $\times 2$. On low phosphorus determinations greater accuracy is obtained by using acid and alkali titrating solutions of N/20 strength.

Manganese.—The 25 cub. cm. portion is placed on the hot plate after adding 15 cub. cm. of silver nitrate solution (5 grammes of silver nitrate to a mixture of 400 cub. cm. nitric acid and 600 cub. cm. of distilled water). Heat to incipient boiling. Then add 15 cub. cm. of ammonium persulphate solution (140 grammes of ammonium persulphate dissolved in 1,000 cub. cm. of water). Continue heating for half a minute after oxidation begins and bubbles arise freely. Set aside or cool under tap until it reaches room temperature. Titrate with standard sodium arsenite to the loss of the permanganate colour. The addition of 10 cub. cm. of sodium chloride solution (5 grammes of sodium chloride in 500 cub. cm. of water) aids in obtaining a distinct end point.

To find a factor for the sodium arsenite solution, calculate from the cub. cm. necessary to destroy the pink colour on a 0.25-gramme sample of a standard iron or steel.

Oxygen in Metallurgy.—Use of oxygen for the enrichment of the blast, and in practically all phases of pyro-metallurgical work, will furnish the key to success in the further development of such metallurgical operations, according to Dr. F. G. Cottrell (formerly Director and now Consulting Metallurgist of the U.S. Bureau of Mines), who first directed the Bureau's attention to this subject. Through this enrichment it is hoped to increase the efficiency of metallurgical operation, with a resultant production at lower cost and possibly the use of lower-grade ores. The Bureau now has outlined plans for two studies which will be carried on simultaneously. The first will cover the present-day processes for the production of oxygen, in order to determine the feasibility of attempting to produce oxygen, or oxygenated air, in such amounts and at such a cost as to admit of its use in metallurgical operations. The second study will be devoted to the feasibility of using oxygen, or oxygenated air, in metallurgical operations. Owing to his interest in this investigation, Mr. M. H. Roberts (vice-president of the Franklin Railway Supply Company) was asked to select an advisory committee to work with the Bureau and to be chairman of this Committee. The Committee will consist of Dr. F. G. Cottrell, Prof. W. L. DeBaufre (Chairman of the Mechanical Engineering Department of the University of Nebraska), Dr. D. A. Lyon (Chief Metallurgist of the Bureau of Mines), Dr. R. B. Moore (Chief Chemist of the Bureau of Mines), Dr. R. C. Tolman (Professor Physical Chemistry and Mathematical Physics, California Institute of Technology), J. W. Davis (Mechanical Engineer of the Bureau of Mines), F. W. Davis (Metallurgist of the Bureau of Mines), Frank Hodson (President of the Electric Furnace Construction Company), and P. H. Royster (Assistant Metallurgist of the Bureau of Mines).

Growth and Deterioration of Grey Cast Irons under Repeated Heatings.*

By Thos. E. Hull. (*Past President of the Yorkshire Metallurgical Society*).

The "growth and deterioration" of cast iron under repeated heatings is a matter coming frequently within the experience of every foundryman, and the peculiar property of this metal of increasing in volume under the influence of successive heatings is inherent in the metal and has existed for all time.

It had been noticed long ago, but no careful study had ever been made of the phenomenon, and no previous knowledge has existed of the fact that a bar of grey cast iron can be permanently increased in bulk by more than 40 per cent. of its original volume whilst in the solid condition—until of quite recent years.

Mr. A. E. Outerbridge, of Philadelphia, may be credited as the pioneer in the research work in this direction. Like all good pioneering work, Outerbridge's investigations raised more questions than they settled, and subsequent work entailing a very extensive series of experiments was undertaken by Professors H. C. H. Carpenter and H. F. Rugan, which throw much light on interesting facts, and give a clearer idea of the causes at work in the permanent growth of cast iron.

Common cases showing the growth of grey cast iron on a large scale are very familiar to all. Cast iron annealing ovens 8 ft. long by 3 ft. dia. by 1½ in. thick, which are kept hot for prolonged periods, sometimes grow to 9 ft. in the course of use. Such is the case with furnace grates, range fittings, rolls, ingot-moulds, firebars, grey-iron foundry-chills, etc., which are subjected to alternate heating and cooling, and are frequently distorted and sometimes broken from the same cause. The great fire at Baltimore was of particular interest in this connection, because what had been previously considered acceptable fireproof construction was proved to be unsatisfactory, owing to damage done to the masonry by the growth of the cast-iron members of the ironwork construction. Floor levels were destroyed, and the walls which had in other respects withstood the action of the fire, were found to be unsuited for further use, owing to their having been forced out of the perpendicular from this cause. The same fire also furnished an illustration of the fact that under the same conditions mild steel does not grow, for, in spite of the entire inflammable contents of a 16-storey building being burned, the steel framework remained plumb and intact. Other instances of this kind have been recorded.

Constitutional, Chemical and Physical Properties of Normal Grey "Cast Iron."

Grey cast iron may be defined as an "alloy of iron and carbide of iron, with minor other metals and metalloids—holding graphitic carbon in suspension." It must also be remembered that the metal itself takes up a reasonable volume of occluded gas in the process of solidification, whilst such is the case to a very marked degree in the formation of "graphite" in contact with metals, as has been demonstrated by Moissan. It is now definitely agreed that the elements silicon and carbon and the occluded gases to a somewhat larger degree, are the most important factors in this phenomenon of "growth"—whilst the element phosphorus and its distribution is a contributory cause to a much lesser degree, it is now established as having probably the more important influence in the production of "cracking" of cast iron under these influences. Moreover, it is observed in cast iron that there is a relation between the amount of silicon and the condition of the carbon—as the silicon decreases, more and more of the carbon is found in the combined condition. The constitution of cast iron is, in fact, similar to that of steel in many respects, in that silicon combines with iron to form a silicide, corresponding to a chemical formula FeSi, which is more soluble in iron than is carbon, and consequently throws the carbon out of solution in the form of graphite. The condition of the carbon in cast iron depends, also, to a certain extent, on the rate of cooling—quick cooling tending to produce a hard, white iron, with the carbon in the combined state. Slow cooling produces a grey, soft iron, with the major portion of the carbon in the free state. "White iron" is too hard to be easily machined, and is extremely unreliable owing to brittleness, so that the casting, if it requires any finishing, is unsatisfactory, and a greyer or softer iron must be used. It follows, as a rule, that the higher the percentage of graphitic-carbon contained in the iron, the softer the material. Sulphur occurs in cast iron as manganese sulphide (MnS), where there is sufficient of the metal manganese present, so that manganese is regarded as an efficient "scavenger" to the iron, seeing that it neutralises the evil effect of sulphur in combination with the iron as sulphide of iron (FeS), which would be the deleterious alternative.

Effect of Phosphorus.

Phosphorus combines with the iron to form a phosphide (Fe_3P), which is soluble in iron to the extent of 1.7 per cent., forming a saturated solid solution. Beyond this quantity free phosphide separates out and forms a eutectic, whilst, however, phosphorus forms another eutectic with the carbide of iron (Fe_3C), which Dr. Stead has described as the phospho-carbide-eutectic. These phosphide eutectics all possess comparatively low melting points; they usually segregate in fringes in the metal, which are easily discovered, as giving white areas in the microscopic examination of the iron.

The constituents of grey cast iron, therefore, are:—(*a*) Graphite, usually occurring in flakes; (*b*) ferrite, or pure iron, containing phosphide and silicide in solution; (*c*) phosphide of iron; (*d*) sulphide of manganese, and (*e*) carbide of iron in the form of a phospho-carbide-eutectic. All these constituents are easily distinguishable when a section of the metal, after polishing and etching, is examined microscopically.

In addition to the above constituents, reasonable volumes of dissolved gases are either contained in the metal or are occluded in the free graphite.

Outerbridge's Experiments.

Outerbridge contributed to the transactions of the American Institute of Mining Engineers (1905) a Paper on "The Mobility of Molecules of Cast Iron," and the following is a summary of his results, in so far as they affect the "maximum growth" of cast iron:—

A cast-iron bar 14-13/16 in. × 1 in. × 1 in. was heated 27 times to about 800 deg. C. for one hour. The author remarks, however, that "growth" was very apparent at much lower temperatures, but was much slower. In order to prevent scaling, the bar was enclosed in a wrought-iron pipe, the ends of which were sealed with clay. After this treatment the bar had increased in size to 16½ in. × 1⅛ in. × 1⅛ in., corresponding to an expansion in bulk of 40.98 per cent. In a footnote, it is recorded that this bar was given 12 additional heatings at 800 deg. C., after which its dimensions were—16.625 in. × 1.1406 in. × 1.1406 in., corresponding to a total bulk expansion of 46 per cent., also, that the last six heatings make no appreciable increase in the size of the bar. Ultimate growth was thus reached in about 33 heats. Outerbridge, curiously enough, ventures the statement that this increase in volume of the cast-iron bar is unaccompanied by any change in weight, and hence deduces the argument that the phenomena of "growth" is due to inter-molecular rearrangement. This view, however, has since been discredited, as will be easily seen from the work and researches on this subject of Rugan, Carpenter and other experimentalists.

Experts' Opinions

In more recent experimental work undertaken by Prof. H. C. H. Carpenter to substantiate

* A Paper read before the West Yorkshire Metallurgical Society.

these figures he (Prof. Carpenter) remarks: "If the heating is sufficiently prolonged a growth has been found to take place at much lower temperatures, *e.g.*, cast-iron valves subjected to superheated steam at 205 degs. C. to 315 deg. C. increase in size permanently, although it must be noted that these steam-valve castings are also subject to another factor, namely, high pressure, which condition would greatly accelerate growth."

This is further substantiated by Prof. H. F. Rugan in his contribution to the Iron and Steel Institute in 1912, when in his summary he points out:—

(1) That the temperature encountered in the pipe lines using superheated steam is sufficiently high to produce disintegration in a casting, causing it to "grow" and to become correspondingly weak.

(2) That grey cast-iron fittings of ordinary mixtures are unfit for use in pipe-lines designed for superheated steam.

At a later date, Mr. S. A. Houghton, giving evidence at a B.O.T. Inquiry on the "Explosion of a Boiler Stop Valve Chest at Pinkston, Glasgow," November 10, 1913, remarks:—

"The superheat causes an evolution of gas, and 'growth' of the parts where the graphite existed at the inside of the casting, and that this action causes expansion of the inside metal with consequent opening and porosity leading to further decay."

These opinions of eminent authorities on this subject and on actual failures which have occurred at comparatively low temperatures, speak for themselves on the subject of "growth."

Chemical and Physical Changes during Growth.

Silicon, which exists in the iron as iron silicide or silico-ferrite, is undoubtedly the most potent factor in causing maximum "growth."

The material silico-ferrite under repeated heating and cooling becomes oxidised and changed to a disintegrated mass of iron oxide and silica—the volume of the material increasing consequent on the reaction. Some metallic iron is also oxidised, and this will probably be variable and be dependent upon the distribution of the graphite and the consequent avenues for oxidising gases—also the time and temperature factors in the process of heating and cooling. In this connection the author has repeatedly made examinations of cast iron which had been under high temperature and pressure conditions, for some considerable period, the resulting material being entirely oxide which crumbles to the touch.

Graphite.

Graphitic carbon is essential to "growth" in an indirect way by providing passages or channels for oxygen. The dissimilarity of the co-efficients of expansion of iron and graphite very largely account for the break up and deterioration of cast iron under conditions of heating and cooling. The gases so heated penetrate the iron along the graphite flakes, which have a co-efficient of expansion of 0.00000786, whilst that of the iron is 0.0000118. Graphite is therefore the weakest constituent present, being deformed, disintegrated and broken up.

The researches of Moissan, of the University of Paris, in the production of artificial graphites by simple rise of temperature in various metals is of real use to the study of graphite in iron.

Moissan states there to be several varieties of graphite (as there are of amorphous carbon) with densities varying between 2.10 to 2.25. They burn in oxygen freely at 660 deg. C. The stability of graphite increases with the temperature to which it has been subjected. This reveals itself in the greater or lesser resistance offered to the conversion into oxide, whilst as the melting point of the metal in which the graphite has been formed rises, the resistance offered to oxidation increases.

Moissan has also found in a study of iron graphites produced at a temperature of 1,150 deg. Cent. that the whole of the free carbon in cast iron is not existent as graphite, but is a mixture containing amorphous carbon. Moreover, there are differing varieties of graphite obtained from one and the same metal under varying conditions of temperature and pressure, thus one is led to the conclusion that the temperature attained in the production of the iron and the rate of cooling in the moulds exert important influences on the quality and disposition of the graphite. The iron graphite so obtained gave on analysis a percentage of hydrogen varying between 0.15 to 0.80, whilst the experimentor remarks that this graphite contains nitrogen. Moissan also repeats this experimental production of "iron graphite" under much more elevated temperature influences, obtaining a graphite in increasing fineness of crystal of a purer quality, and possessing greater stability towards oxidising conditions.

Moissan's Conclusions.

In view of the extensive research of Moissan, his conclusions are of interest to us on the subject of "growth."

(1) All the graphites he examined up to this point contained hydrogen. This hydrogen results either from a physical phenomenon of condensation of "gaseous" hydrogen in graphite (which view Cailletet supported long ago), or from chemical action.

The presence of combined carbon has been found to be of almost a negligible factor in the process of growth, whilst the presence of manganese modifies the action of silicon, for the reason that graphite formation is hindered, and consequently the rate and amount of "growth" is retarded by its presence.

In the case of the phosphide eutectic there is evidently a variety of opinion amongst investigators as to its effect upon growth and deterioration.

The author's opinion is that whilst the presence of phosphorus is not an important factor to "growth," it is important under temperature influences in producing disintegration and deterioration.

It must always be remembered that at a dull red temperature the phosphide-eutectic is quite near its melting point, and if softening does occur, the production of cracking will be more easily assisted.

In the production of pistons for internal combustion engines the avoidance of this trouble may be assisted in the provision of a low-phosphorus iron.

The author is of the opinion, after the study of frequent failures of cast iron under high pressures and superheated steam, that the presence of the phosphide areas present an easy target for "attack," leading to the elimination of the eutectic and leaving to microscopic view the replacing cavities.

As to the physical changes during "growth," the increase in weight in the iron accompanying its growth is resultant of the process of oxidation, whilst if the growth be further extended a final position would arise of the metallic iron being converted into oxide. The net increase in weight is the result of oxidation of the silicon and iron, less the carbon oxidised to CO_2.

The Influences of Gases on Growth.

All metals contain comparatively large volumes of "occluded gases," and that these imprisoned gases play an important part in the question of "growth" is indisputable. There is no doubt that grey cast irons absorb large volumes of gases, chiefly hydrogen, nitrogen and carbon-monoxide, during the process of melting, as is the general case in an open furnace, and more especially in the conditions prevailing in the cupola.

It is interesting to note that Moissan's experiments previously acknowledged were conducted in the ideal metallurgical atmosphere of the electric furnace, which must tend to convey to the metal and to the graphite segregate the minimum of gas occlusion.

Moreover, Moissan has shown that all graphites obtained from a liquid metal at a high temperature, whether by a difference of solubility or by chemical reaction, have the property of swelling readily when heated to dull redness, which swelling is attributed to a sudden evolution of gas, and to which varieties he has termed "intumescent graphites." The graphites produced under high temperature influences swell at temperatures varying between 165 and 175 deg. C.

Through the agency of these imprisoned gases in the iron, in its original cast condition, the process of repeated heatings would set up an internal pres-

sure of gas which can only be liberated at the boundaries between the solid solution and the graphite, by this means exercising a purely physical function, which of itself will contribute to "growth," but in this disintegrating process enabling with greater freedom the chemical changes to affect the whole structure.

The general influence of gases on "growth" appears to be of *real* importance, and actually the first step in the disintegration of cast iron under the conditions of frequent heatings.

General.

It is interesting to note that mild steel under microscopical examination shows two structural constituents, ferrite or pure iron, and pearlite, a eutectoid of ferrite and carbide of iron, the coefficients of expansion of these two constituents being almost identical, whilst they are both mechanically strong.

Rolled steel on being heated and cooled a large number of times shows a tendency to contract slightly.

It has been suggested that the reason of the shortening of the rolled steel was that the elongated grain of the steel produced in rolling, assumed a normal round shape again, on reheating, and thus contracted in length; whilst it is interesting to note that cast steel, which cannot be subjected to rolling, does not appear to have this tendency.

The question may be asked, how is it that in the face of the many failures of cast-iron steam-valves, chests, pipes and superheaters, the cast-iron engine cylinder, and more especially the liners and pistons of the internal combustion engine, still survive? The answer is probably that the film of lubricant to which the face of the piston and cylinder is always subjected, has had the desired effect of warding off to some extent the deterioration attack, and thus making the retention of these castings possible, in spite of many troubles. The entrance of lubricant under the influence of heat and gas pressure into the interstices of the grains by way of the graphite plates, proves troublesome, in the preparation of micro-sections from such faces, which persistently show the presence of lubricant even after very careful cleaning.

In the case of engine cylinders, as a general rule, the temperature conditions are not very high, it being generally understood that so long as "dry" steam was admitted into the cylinder the conditions were all as required.

Summary.

A summary of the chief factors at work in the growth and deterioration of cast iron would, in the author's opinion, be tabulated in the order of their importance as follows:—

(1) The oxidation of the silico-ferrite and the consequent expansion of the products of oxidation must account for the major increase in bulk of the iron in the early stages of growth.

(2) The occluded gaseous consituents of the iron are no doubt the prime factor in the *early* growth of the metal, and in reality are the starting point, being liberated under pressure, causing the deformation of the graphite crystals and opening up suitable avenues for their removal.

(3) The element phosphorus and its distribution, whilst being a contributory cause of growth *to a very small degree* is no doubt sometimes responsible when present in sufficient quantity for the production of the cracking and the break-up of the material under these influences.

(4) In cases approaching the total expansion, the free iron is oxidised and accounts for maximum growth.

Conclusion.

British steam users have very largely adopted steel pipe lines and valves for high-pressure and superheat, which largely explains the official figures covering accidents on steam generating plants in this country—comparatively few—as compared with the American official figures, where the common practice is still to a large extent cast iron and semi-steel, which terms, metallurgically, are almost synonymous as referring to the subject to growth.

For the conveyance and distribution of high pressure and superheated steam, steel apparatus represents the hall mark of "Safety," and is a material which is more naturally suited and responsive to the alternating expansions and contractions to which it is submitted.

With reference to castings required to withstand the severe conditions of the internal-combustion engine, the manufacture of these in electrically produced synthetic cast iron would go a long way to mitigate the many difficulties encountered.

The electric melting process is, metallurgically, preferable to, say, cupola practice in every respect, whilst the composition of the resulting iron is variable at will, giving easy control of those elements which are the important factors in growth.

The disposition of the graphite in cast iron when produced in the electric furnace is as small crystals in the case of low total carbon—in contradistinction to the commonly-occurring form in cupola iron, namely, elongated flakes, whilst an iron produced synthetically is of small grain size, mechanically stronger and of a softer nature for machining in spite of its lower total carbon and silicon content.

Thermal Expansion of Metals.

Scientific Paper No. 426 of the U.S. Bureau of Standards includes original data on the thermal expansion of samples of commercial nickel, monel metal, stellite, stainless steel, and of exceptionally pure aluminium. All of these materials except stainless steel were examined from room temperature to about 600 deg. C. The samples of stainless steel were heated from room temperature to 900 deg. C.

Commercial Nickel (94 to 99 per cent. Ni).—Five samples were hot rolled, and the other five samples of corresponding compositions were hot rolled and annealed. In most of the expansion curves of these samples of commercial nickel a slight irregularity was perceptible in the region near 350 deg. C., but there was no marked change or anomalous expansion such as was observed by previous investigators in the case of pure nickel. Annealing of the hot rolled samples of nickel usually caused a slight increase in the values of the coefficients of expansion.

Monel Metal (60 to 69 per cent. Ni).—Two samples were cast, and three were hot rolled. Five other specimens of corresponding compositions and treatments received additional treatment, that is, they were annealed. The expansion curves of monel metal were found to be fairly regular. The average coefficients of expansion of the various samples for the range from 25 to 300 deg. C. were all practically equal. For the temperature range from 25 deg. to 600 deg. C. the average coefficients of the cast samples were greater than those of the hot rolled alloys.

Stellite (five samples of various grades).—The expansion curves showed irregularities in the region between 300 and 500 deg. C. The stellite containing 10 per cent. tungsten had the smallest coefficients of expansion of all the samples investigated. The hammered stellite had smaller coefficients than the unhammered sample of corresponding composition, which indicated that hammering may lower the values of the coefficients of expansion.

Stainless Steel.—The expansion curves, including the critical regions of an annealed and a hardened sample of stainless steel were determined. On heating, both samples indicated critical regions which extended from about 825 deg. to about 855 deg. C. The transformation point of cooling occurred at about 800 deg. C. Up to the transformation regions the heating and cooling curves of the annealed sample were fairly regular. In the case of the hardened stainless steel the curve was irregular between 200 and 400 deg. C., where the strains produced in hardening were released. Above 400 deg. this sample behaved like the annealed specimen. The coefficients of expansion of these stainless steels were less than the coefficients of ordinary iron or steel.

Aluminium (99.74 per cent.).—The thermal expansion of the two samples of cast aluminium investigated between room temperature and 600 deg. C. may be represented by the following empirical equation:—

$$L_t = L_0 [1 + (21.90\, t + 0.0120\, t^2)\, 10^{-6}].$$

where, L_t = the length corresponding to temperatures, and L_0 the original length.

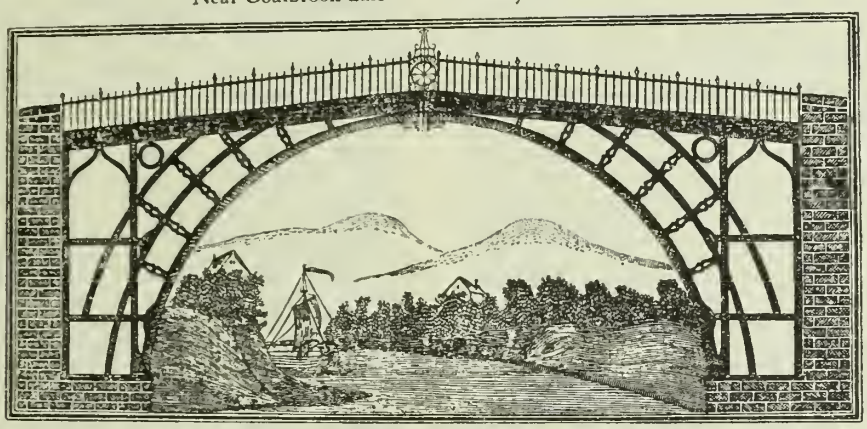
Coalbrook-dale Bridge.

During the discussion on the historical section of Mr. Flavell's presidential address before the Birmingham Branch, Mr. W. H. Moore introduced the question of the old bridge at Coalbrook-dale, and was sufficiently kind to send us a photograph of an old print, which we reproduce below. Beneath the print there appears the following description:—

"This amazing structure was cast at Coalbrook-Dale in the year 1778, and erected in the years 1779 and 1780. The expansion of the Arch is 100 Feet within, and its height 45, which, with the additional height of the Walls it is supported on, makes it near 55 Feet from the Water. It is composed of five such Arches as above represented, standing about two yards asunder, which form a Road over the top of about 10 yards wide and 100 in length, cover'd with strong Iron Plates.

"Notwithstanding the great weight of the several pieces which form these Arches (many of them containing more than six Tons of Metal), the height to which they were raised, the difficulty with which they were fixed into the several mortices, etc., prepared for them, the whole was conducted with such care and skill that not any material accident has happen'd either to the Men or Work. The whole Bridge is computed to contain 500 Tons of Iron. The Parishes of Madeley and Benthal are the Atlasses that bear the enormous

A View of the Iron BRIDGE, erected over the River SEVERN, Near Coalbrook-dale in the County of SALOP.



Load, one foot being plac'd in the first, the other in the last-mention'd Parish; where it now stands an indisputable proof of the abilities of our Mechanics and Workmen."

Further reference is made to this bridge in the introduction to a book entitled "A Practical Essay on the Strength of Cast Iron and other Metals," by Thomas Tregold, the second edition of which was published in 1823. The reference is in the form of a footnote, which is worded as follows:—

"One of the boldest attempts with a new material was the application of cast iron to bridges. The idea appears to have originated, in the year 1773, with the late Thomas Farnolls Pritchard, then of Eyton Turrett, Shropshire, architect, who, in communication with the late Mr. John Wilkinson, of Brosely and Castlehead, ironmaster, suggested the practicability of constructing wide iron arches, capable of admitting the passage of the water in a river, such as the Severn, which is much subject to floods. This suggestion Mr. Wilkinson considered with great attention, and at length carried into execution between Madely and Brosely, by erecting the celebrated Iron Bridge at Colebrook Dale, which was the first construction of that kind in England, and probably in the world. This bridge was executed by Mr. A. Daniel Onions, with some variations from Mr. Pritchard's plan, under the auspices and at the expense of Mr. Darby and Mr. Reynolds, of the ironworks of Colebrook Dale. Mr. Pritchard died in October, 1777. He made several ingenious designs, to show how stone and brick arches might be constructed with cast-iron centres, so that the centre should always form a permanent part of the arch. These designs are now in the possession of Mr. John White, of Devonshire Place, one of his grandsons, to whom I am indebted for the preceding particulars of this note."

It is worthy of note that in Mr. Tregold's book a distinct effort is made to prove the superiority of cast iron over wood. The testing of cast iron at that period seemed to be mainly confined to the transverse method.

Synthetic Pig-iron on the Pacific Coast.

British iron, especially Scotch, often finds a ready market on the Pacific Coast of the States. The following extract from the "Iron Age" therefore assumes some importance to the British pig-iron producer.

As is well known, pig-iron is not produced on the Pacific Coast at the present time in sufficient quantities to meet the demand for iron of such grades as are required for foundry purposes. As a result, foundry iron is costly, due to high freight rates on eastern iron that is brought in and to the high cost of coke suitable for use in the cupola. On the other hand, considerable steel scrap is to be had, and, for that reason, attention has been recently given by the members of the electrometallurgical section of the north-west station of the American Bureau of Mines at Seattle, to the problem of determining the best conditions for the production of cast iron by melting scrap steel in the electric furnace. These conditions were established by numerous experiments conducted in a laboratory furnace holding 300 lb. of metal.

Later on these conditions were applied in a local foundry with excellent results. Low-grade miscellaneous steel scrap was melted and carburised in a 3,000-lb., direct-arc, 3-phase electric furnace, and the resultant metal discharged into the pouring ladle and then into the moulds for the miscellaneous grey-iron castings which made up the normal output of the foundry. The carbon and silicon content of the product was under control at all times, and the furnace operator had no difficulty in producing the grade of iron required. Satisfactory castings were made with the normal consumption of power and electrodes.

Compressed Air Film.

A cinematograph film has been produced through the collaboration of the Compressed Air Society, the American Bureau of Foreign and Domestic Commerce and the American Bureau of Mines, to show methods in which different types of compressed air apparatus are utilised in various spheres of activity, and is entitled "The Story of Compressed Air."

The film includes the modern foundry which rams moulds, sifts sand, removes cores, and cleans, chips and grinds castings by means of air. Particulars regarding the film will be furnished by the Compressed Air Society, 50, Church Street, New York.

Trade Talk.

Another furnace is to be relighted at the Millom Ironworks immediately.

The Dowlais Works of Guest, Keen & Nettlefolds, Limited, have been re-started.

The imports of foreign ore at the Lonsdale dock, Workington, last month were 7,070 tons, compared with 8,000 tons for September.

The Ramsay Engineering Company, Limited, have removed to 201, Mansion House Chambers, 25, Queen Victoria Street, London, E.C.4.

E. J. Smith & Company, Tyseley Metal Works, Birmingham, have established a branch at Cleveland Buildings, 94, Market Street, Manchester.

Hobdell, Way & Company, Limited, have removed to 45, Church Street, Minories, E.1. The new warehouse is situated in Haydon Square, Minories.

G. Curtis Holt & Company, Limited, 2, Basinghall Street, Leeds, who specialise in air-compressors, receivers, moulding machines, and cupola blowers, have opened a branch at 5, Blackfriars Street, Manchester.

Professor W. Cramp, chairman of the South-Midland Centre of the Institution of Electrical Engineers, delivered his presidential address before a large audience in the Grand Hotel, Birmingham, on October 25.

The imports of foreign ore at the Senhouse dock at Maryport during October have been 3,500 tons, compared with 12,000 tons for September and 3,700 tons this time last year. Last week's imports totalled 3,000 tons.

Bell Brothers (Manchester), Limited, engineers, 5, Deansgate, Manchester, have removed their works from Ravensthorpe and their offices from Manchester to the Calder Iron Works, Ashton Road, Denton, Manchester.

"The Welding of Metals and Consequent Changes in Structure and Composition" was the subject of an interesting paper given by Mr. E. A. Atkins to the members of the Sheffield Association of Metallurgists and Metallurgical Chemists last week.

Vickers, Limited, have received an order for the building of a steamer of 20,000 tons displacement for the Orient Line. She will be fitted with single reduction geared turbines and use oil fuel, and will be built at the Naval Construction Works, Barrow.

The final draft of a new Peruvian tariff has been completed and introduced into the Peruvian Senate, and it is probable that the Bill will be passed in time to come into effect by January. Machinery for mining is on the free list, while other machinery is to be admitted at considerably reduced rates.

The proposals for the reconstruction of the Ropner Shipbuilding & Repairing Company, Stockton, Limited, are: For each preference share, 10s. in cash and two preferred ordinary shares of 5s. each, also an 8 per cent. dividend. For each two ordinary shares, 5s. in cash and one deferred ordinary share of 5s.

Among the questions which the Society of Technical Engineers has arranged to put to candidates at the General Election is the following:—Are you in favour of an attempt to arrange that the cost of unemployment insurance of manual workers within an industry shall fall partly on that industry, so that there will be a stimulus to regular output in such a way that employment will be more uniform than hitherto?

The Turbine Furnace Company, Limited, have lately received orders for their furnaces from 22 companies, including the United Steel Companies, Limited, James Brownlee & Sons, Limited, the Maltby Main Colliery Company, Limited, the Port of Melbourne Engineering Works, William Cooper & Goode, Limited, Hughes Stubbs Metal Company, Limited, the Leys Malleable Castings Company, Limited, and the Butterley Company, Limited.

The Wellman Smith Owen Engineering Corporation, Limited, of London and Darlaston, have secured contracts from the Consett Iron Company, Limited, of Co. Durham, for the bulk of their new steel plant, consisting of the following:—Ten cranes, including charging machines, ladle cranes, magnet cranes, etc.; ingot stripper; and the design and construction of open-hearth furnaces, soaking pits and reheating furnaces. The Wellman Smith Owen Engineering Corporation are also manufacturing the coke-oven machinery.

The Boving Engineering Works, Limited, constructional engineers, ironfounders and boilermakers, 4, Broad Street Place, London, E.C.2, announce that they have taken over the business in ZV and Union patent flexible couplings, Ruggles Coles rotary dryers and Electro Metals patent two-phase electric steel furnaces, which was carried on by Electro-Metals, Limited, of 56, Kingsway, London, W.C.2. The head office of the company will be at Broad Street Place, but the manufacturing side of the business will be continued, as hitherto, at the company's works at Stoke-on-Trent.

Company News.

Aldridge & Ranken, Limited, 39, Victoria Street, London, S.W.1.—Capital £40,000 in £1 shares. Engineers. Directors: J. G. W. Aldridge, A. W. Ranken, H. J. T. Aldridge and T. J. Ashley.

Gilbert Austin, Limited.—Capital £40,000 in £1 shares. General engineers.

Brooks & Doxey (1920), Limited.—Interim ordinary dividend, 9d. per share, free of tax.

John Brown & Company, Limited.—Interim ordinary dividend, 5 per cent. per annum.

Brunner, Mond & Company, Limited.—Interim dividend, 7½ per cent. per annum, less tax.

Controlled Industries, Limited, 181, Shaftesbury Avenue, London, W.C.2.—Capital £10,000 in 9,000 cumulative preference shares of £1 and 20,000 ordinary of 1s. Engineers and manufacturers, etc. Directors: G. W. Pearson, R. W. Gillespie, F. R. Pool (managing director), and J. M. Greenhalgh.

George Ellis & Company, Limited.—Capital £5,000 in £1 shares. Engineers.

Guest, Keen & Nettlefolds, Limited.—Interim ordinary dividend, 1s. per share, free of tax.

M. Hayes & Son, Limited, Quay Street, Gloucester.—Capital £10,500 in 4,500 ordinary and 6,000 7 per cent. cumulative preference shares of £1. Metal founders.

Richard Johnson, Clapham & Morris, Limited.—Interim ordinary dividend, 5 per cent. per annum.

Constantino Secchi, Limited, 179, Westminster Bridge Road, London, S.E.—Capital £8,000 in £5 shares. Engineers.

Parker & Hope, Limited.—Capital £1,500 in 1,000 preference of £1 and 1,000 ordinary shares of 10s. each. Engineers. Directors: Mabel E. Hope, J. W. Hunter and G. B. Robinson.

Stewardson & Company, Limited, 37, Albert Street, Edinburgh. Capital £15,000 in £1 shares. Engineers, coppersmiths and brassfounders.

Leo Sunderland & Company, Limited, 40, Albemarle Street, London, W.—Capital £10,000 in 9,000 10 per cent. cumulative preference shares of £1 and 10,000 deferred of 2s. Engineers.

H. W. Sullivan, Limited, Winchester House, Old Broad Street, London, E.C.—Capital £20,000 in £1 shares. Electrical engineers. Directors: H. W. Sullivan and C. D. Medley.

Vefco, Limited.—Capital £1,000 in 975 10 per cent. cumulative participating preference shares of £1 each and 1,000 ordinary shares of 6d. Iron and metal merchants, etc. Secretary: H. H. Foster, 805, 6 and 9, Salisbury House, London, E.C.2.

Wilson Bros. (Leeds), Limited, 46, Victoria Road, Holbeck, Leeds.—Capital £15,000 in £1 shares. Machinery manufacturers.

W. M. Waddell, Limited.—Capital £3,650 in 3,350 preference shares of £1 and 6,000 ordinary shares of 1s. Iron manufacturers. Director: H. F. Perry.

Wyndham Simplex Company, Limited, 83, Weston Park, Hornsey, London, N.8.—Capital £300 in £1 shares. Engineers. Directors: J. W. Meck and H. C. Foulkes.

Gazette.

Trading in the style of the Worcester Pattern Making Company (Messrs. F. W. Avery, S. W. Rea and H. Sharp), Worcester, engineers and pattern makers, have dissolved partnership.

Westwood Engineering Company (Wigan), Limited.—It has been resolved that the company be and is hereby placed in voluntary liquidation. Mr. G. H. Turner, Areade Chambers, Wigan, has been appointed liquidator.

Trading in the style of Crossley & Company (Messrs. H. Crossley, R. Leach, and B. Overfield), Cowhill Brass Works, Oldham, brass founders, finishers and engineers, have dissolved partnership. Debts by Messrs. H. Crossley and R. Leach, who continue the business.

Trading in the style of the Midland Panel Company (Messrs. J. Brookes, B. Winspur, H. Pickering, H. Newey, and W. J. Bishop), corner of Grant Street and Bell Barn Road, Edgbaston, Birmingham, metal workers, have dissolved partnership. Mr. J. Brookes retiring from the firm.

Mr. Edward Manville, Conservative candidate for Coventry, who was taken ill after his adoption meeting, is confined to his London house, and, his condition having become worse, he will be unable personally to take part in the contest. Mr. Manville is a member of the Council of the F.B.I., and a director of the Birmingham Small Arms Company, Limited.

IRON AND STEEL MARKETS.

Pig-iron.

Activity in the various pig-iron markets during the current week has been considerably restricted by electioneering excitement, a disturbance which, though only temporary, has naturally affected both buying and selling movements for the time being. In the Midlands, however, producers generally report a steadily growing demand for foundry pig, of which the foundries generally are now taking increased supplies, while forge qualities are also going into consumption on a slightly better scale than has been experienced for some time. In South Staffordshire smelters have just cause for complaint that the price of fuel, especially coke, is practically maintained at the level to which it was advanced recently owing to the American demand, while it has not been possible to secure an adequate increase in the selling price of iron. The most it has been possible to do so far is to firm up quotations. In the Scottish market the anticipated renewal of American buying has not yet developed, although there has been some inquiry, and one or two lots have been put through, but the tonnage is not of any account. Meantime, Scotch prices are easy, and those makers who have only recently put their furnaces in blast could be tempted, with a decent parcel, to cut their price. For what orders are available there is keen competition amongst dealers. At Middlesbrough last week markets were well attended, and business, though comparatively restricted in volume, showed a steady tendency. Home consumptive demand affords evidence of gradual expansion, but for the present the furnaces now in blast appear equal to requirements, with outputs generally fully absorbed. In the export department deliveries on American account are still going forward, of course on a diminished scale. Several cargoes for prompt and December shipment have been negotiated during the past week, and the demand for foundry iron to special analysis still continues, sales having been effected extending to next March. The call from the Continent, on the other hand, is more or less negligible, owing not only to the current high prices, but to the extraordinary difficulties of the exchange situation. Foreign competition is again becoming active, Continental No. 3 of good quality now being offered in this country at a figure well below the Cleveland price, but consumers who are accustomed to a particular brand are not very inclined to take the risks of quality, or of delivery. Meanwhile, makers have plenty of orders in hand, and several are fully sold for some weeks ahead. Prices, accordingly, are firmly held at recent levels as follows:—No. 1 and silicious, 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s.; mottled and white are nominally 82s. 6d., but could probably be done at a figure rather nearer 80s. per ton.

Demand for hematite remains steady, with but little change from recent reports. As regards the home trade, there is undoubtedly a better feeling, but business with the Continent is necessarily erratic and spasmodic. On the whole, however, the position generally has shown remarkable improvement in recent weeks. Makers' order books are healthy, stocks are very low, and quotations continue firm. For East Coast mixed numbers 93s. is named, with a premium of 6d. to 1s. per ton for the No. 1 quality.

Finished Iron.

Market movements in connection with finished material, though still restrained within narrow limits, point in the direction of, a more active inquiry with perhaps, a much improved prospect of materialising later into actual business than has been experienced for some time past. Hopes are at all events, now entertained of a larger and better sustained demand from the consuming industries, reports current indicating the placing of orders for railway wagons and of increasing activity in the mechanical engineering works, and undoubtedly there is some movement in those directions; but some time must elapse before they can be described as actively employed. There is, however, severe Continental competition being experienced again, while the disparity between the quotations for the home and the foreign material places the local manufacturer at a disadvantage. This drawback is convincingly apparent in the case of common Belgian bars which are being offered at Birmingham at £7 10s., whereas the lowest price quoted for the corresponding quality of South Staffordshire iron is £9 12s. 6d. This competition has materially reduced the volume of business and makes it more difficult to carry on. The better qualities of bars are not affected (except sympathetically) by this competition. Good crown bars still make £10 10s., and in some cases 5s. more, but, of course, the demand is not very active at the higher price. Makers of iron strip are finding it very difficult to carry on. Orders are most difficult to obtain at the price which the cost of production makes imperative, especially as steel strip can be obtained so much cheaper.

Scrap.

Reports from the principal centres of the scrap metal trade point uniformly to a gradual extension of business, of which an outstanding feature continues to be the steady increase in inquiries for heavy steel qualities, for which prices are stiffening at Sheffield and the Midlands. In the latter district also, there is an improved demand for wrought-iron scrap, while in Lancashire the inactivity in the foundry industry is reflected in a poor demand for cast-iron qualities. On Tees-side the demand for heavy steel scrap continues unabated and the price is firmly held at 68s. per ton, delivered works. Other descriptions are unchanged, and the prices, all delivered works, are as follows:—Heavy steel turnings, 54s.; c.i. borings, 52s. 6d.; heavy cast-iron machinery scrap in handy pieces, 75s. to 77s. 6d.; heavy wrought-iron bushelling scrap, 55s. to 57s. 6d.; ordinary heavy piling, 60s.; specially selected heavy forge, 70s. to 75s. per ton.

Steel.

Conditions in the steel industry, as far as market operations are concerned, show little variation from those obtaining during the past few weeks, but manufacturers on the whole report a slight improvement in the business coming forward, with more employment in some of the branches. As some indication of returning activity in the trade may be noted steady buying of late in the ferro-alloys market, a fairly steady business now passing in small tonnages of ferro-silicon, chiefly 45/50 per cent. grade. Silico manganese has been called for, and 50/55 per cent. Mn. contained material has been bought at well under £16 per ton for a fair quantity. Ferro-manganese is also a little more in demand for home consumption, but Continental calls are falling off. In addition to this, the American demand is also slack. Semi-products of late have been only in quiet demand, notwithstanding more active conditions in the tinplate trade, and makers report some scarcity of specifications. Considering that the Belgians are anxious to book business at about £5 for blooms, £5 7s. 6d. for billets, and £5 14s. for slabs, delivered Welsh ports, the local makers are not likely to book much on their basis of £6 for soft steel billets. The Association have fixed the price for tinplate bars at £7 7s. 6d. for the remainder of this year, and £7 10s. for the first quarter of next, with the usual rebate to consumers adhering to the tinplate minimum. The more active conditions in the tinplate market are maintained, but a considerable quantity of the business placed is of a speculative character. The advance in the price of tin has entered largely into the enhanced value of tinplates, and the current price is now nearer 19s. 6d. per box than the minimum of 19s. 3d.

Metals.

Copper.—During the past week there has been a distinct revival of buying in the market for standard copper, and though there has been no sensational movement in prices the tone is satisfactorily steady. Consumptive demand at home is still restricted, although perhaps slowly improving, and export markets are also quiet; the accentuated weakness in Continental exchanges having severely restricted the capacity of Europe to buy; whilst India fails to give much encouragement to the manufacturers of the special descriptions of metal in which she is usually interested. Under the circumstances, values might easily have tended to recede, but there exists a considerable amount of latent faith in copper at ruling quotations, and this acts as a support when the market is inclined to listlessness. Current quotations:—*Cash*: Wednesday, £63 2s. 6d.; Thursday, £63 5s.; Friday, £63 12s. 6d.; Monday, £63 15s.; Tuesday, £63 7s. 6d. *Three months*: Wednesday, £63 17s. 6d.; Thursday, £64 2s. 6d.; Friday, £64 10s.; Monday, £64 12s. 6d.; Tuesday, £64 5s.

Tin.—Movements in the market for this metal have, of course, claimed much more interest than other sections, and although values have shown occasional irregularity, quotations recently have soared to record heights for the current year. Although, so far, no announcement on authority has been made, the probability increases that the Federated Malay States will seize the opportunity of unloading their stocks, and, indeed, it appears that no more favourable time, from

their point of view, could be chosen. America, while not making purchases of any magnitude, has afforded the market steady support, while good quantities of forward metal have been taken on Dutch account. Current quotations :—*Cash* : Wednesday, £180 17s. 6d. ; Thursday, £184 10s. ; Friday, £184 5s. ; Monday, £182 7s. 6d. ; Tuesday, £182 7s. 6d. *Three Months* : Wednesday, £181 10s. ; Thursday, £185 ; Friday, £184 15s. ; Monday, £182 17s. 6d. ; Tuesday, £182 17s. 6d.

Spelter.—In the market for this metal there seems every probability of a famine in supplies, and a steady appreciation of prices is in evidence, the quotation for prompt delivery having risen 32s. 6d. per ton to £39 2s. 6d. under pressing demands from consumers. Messrs. Rudolf Wolff & Company state that consumers have bought pretty freely again, more especially early in the week, but even now do not seem to be particularly well covered. Current quotations :—*Ordinary* : Wednesday, £38 5s. ; Thursday, £38 17s. 6d. ; Friday, £39 2s. 6d. ; Monday, £39 2s. 6d. ; Tuesday, £38 17s. 6d.

Lead.—The market for soft foreign pig has been irregular, with prices during the current week practically unchanged. Consumption is well maintained, while production is inadequate, though improving. Current quotations :—*Soft foreign (prompt)* : Wednesday, £26 15s. ; Thursday, £27 15s. ; Friday, £26 10s. ; Monday, £26 10s. ; Tuesday, £26 12s. 6d.

Book Reviews.

Lehrbuch der Eisen-und Stahlgiesserei. By Bernhard Osann.—Leipzig : Wilhelm Engelmann, Mittelstrasse 2. (Price, bound, 950 marks, plus surcharge for currency depreciation.)

When reviewing the fourth edition of this book we described it as a comprehensive encyclopædia of the founder's craft, written for both students and workers in actual practice in the foundry. As not much more than a year has elapsed since that edition was published and a new (the present fifth) edition had to be issued, no material alterations have been made. The text has been revised, however, in response to letters and suggestions received by the author, and advantage has also been taken of the experience gained by him at visits to works and attendances of meetings of technical societies. The table of contents has also been modified.

Publications Received.

"Shall the State Throw Away the Keys." Published by the Association of British Chemical Manufacturers, 166, Piccadilly, London, W.C.1. This book is an appeal for State aid for the branches of the chemical industry, which were a German monopoly before the war. An interesting foreword has been written by Sir Wm. J. Pope.

The Heat Treatment of Cast-Iron.*

The author gives the results obtained with four samples of cast iron of varying compositions. After annealing for 45 min. at 900 deg. C. 1,652 deg. F.) and cooling slowly in the furnace, the tensile strength was reduced by 20-38 per cent., although the resistance to impact was not appreciably altered. This diminution was found to be due to the separation of graphite to the extent of 0.12-0.5 per cent. He recommends, therefore, that any annealing should be carried out at a temperature below that at which this separation takes place. This becomes lower as the silicon content is raised. The result of quenching in oil from 900 deg. C. and tempering at 650 deg. C. (1,200 deg. F.) was to increase the tensile strength by 20-30 per cent. in the case of three specimens, but only by 8 per cent. in the case of the fourth, owing to the low proportion of combined carbon, which formed only 10 per cent. of the total carbon-content. The ratio of the resistance to impact after treatment to that before ranged from 1.6 to 3.7. Somewhat similar results might be expected in the case of semi-steel used for projectiles.—J. Durand. (*C.R.*, 174, 748-751.)

Semi-Steel.*

Semi-steel (*fonte acierée*) was used to a considerable extent by the Allies for projectiles, and the author suggests that there is a considerable commercial field for its employment. He describes its physical properties, and states that its resistance to repeated impact is about six times that of cast iron, while the ultimate tensile stress is about double. The chemical characteristics are given as : S, less than 0.12 per cent. ; P, less than 0.2 per cent. ; total carbon content, less than 3.2 per cent. (of which approximately three-quarters is in the graphitic state) ; Mn, 0.7-0.9 per cent. ; and Si, 1-1.8 per cent. The various methods of associating the iron and the steel and the regulation of the proportion of graphitic carbon by adjusting the silicon content, are described. Numerous experimental results are tabulated and plotted, and the author comments upon these and explains the influence of the chemical composition upon the physical properties. Precautions to be taken during production are touched upon, and it is suggested that a shear test and a Brinell hardness test would afford sufficient evidence on which to accept or reject the material.—Prache. (*Rev. Mét.*, 19, 1-10.)

* Institute of Civil Engineers' Abstract.

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Contents.

	PAGE
The Works' Metallurgist	419
Coke Requirements of the Iron Trade	420
The Design and Construction of Runner Heads	422
The Steel Foundry of Messrs. Thwaites Brothers	423
Importance of Temperature in Bessemer Converters	426
German Iron and Steel Industry	426
Defects in Brass Tubes	427
An Apprenticeship Course in Foundry Practice.—XIX.	429
The New Parliament	430
Correspondence	431
Gazette	431
Death	431
Personal	431
Trade Talk	432
Iron and Steel Markets	433
Contract Open	434
Company News	434
A New American Foundry Technical Association	434

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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The Works' Metallurgist.

The scope of the metallurgical chemist was dealt with by Dr. C. H. Desch, Professor of Metallurgy at Sheffield University, on the occasion of the Streatfield Memorial Lecture at the Finsbury Technical College. He made a strong plea not only for the more extensive employment of the metallurgical chemist, but also the advancement of this class to the directorates. To put it into Dr. Desch's own words:—"Many of us hold that the actual direction of the industry should be largely in the hands of such technically trained experts, and that the frequent absence of such direction is one of the most potent causes of weakness in the industry. The transfer of the control of manufactures from the technical chiefs to boards of financiers and commercial men is a serious fact of the day, deserving the careful attention of all who are interested in the relations of science and industry. It leads inevitably to concentration on finance rather than on manufacture, and to the making of profits assuming greater importance than the making of goods."

Whilst this is admirable in theory, and has quite often worked out well in practice, it should not be forgotten that in many cases the mentality of a metallurgist is entirely different from that of a financier. His early training is all against economy, and the lack of anything appertaining to costs is, in most cases, conspicuously absent from his curriculum. His first introduction to business is the checking of invoices, probably at the age of 21, at which time he is not conversant with the difference between these and a "statement." When, as sometimes happens, the high cost of "sodium bismuthate" or ammonium molybdate is questioned by the accounts department, the metallurgical chemist resents this, as he imagines it to be interference. This typical attitude impairs his advancement on the business side early in his career. The Universities should impress upon all students their sphere in the works on the business side, just as much as on the technical side. The debutant metallurgist should be in a position to demand grants for his routine or research work, and to do this with a knowledge of what the work is reasonably likely to cost. Whilst going further than Dr. Desch and asserting that where metallurgists have won for themselves the appellation of "captains of industry," they have been a conspicuous success, they have earned it, not on account of their metallurgical training, but in spite of it. We emphasise this plea for some business training to be included in every metallurgical course, as we feel sure, that if properly presented it would modify materially the aspect of much research work. Instead of producing complete details of the mechanism of the alloying of two metals, the research would be stopped after ascertaining the salient points and other work, having commercial possibilities, would be undertaken. The former could be left to the pure physical chemist as distinct from the metallurgist, and any data should be presented to physical and not metallurgical societies. We believe this course to be essential, as there is so much work of industrial interest which is so pressing that metallurgical societies have little or no time for academic research. The previous pleas which we have made for both practical and academical workers to become technical have been misunderstood by some, as they failed to differentiate between technical and academical. That there is such a difference can be exemplified by again quoting Dr. Desch, who says: "The degree of accuracy required in such analyses (high-speed steel and the like) for commercial and technical purposes is surprising to a chemist unaccustomed to such work, and is far in advance of the standard usually accepted in academic laboratories." Here, again, it is the non-realisation of commercial and practical conditions, which render the academical man's communications to technical societies so uninteresting, and necessitates their re-education, so as to include commercial aspects. Unless this is realised in the future, business men will withdraw their support from institutions which churn out year after year physico-metallurgical investigators of no industrial application, and will spend their money in private research laboratories, and so the amount of co-operative research which should be of the greatest value will diminish to the detriment of industry at large.

Coke Requirements of the Iron Trade.*

By A. Young.

General Requirements.

Foundry managers require a coke which will be freely combustible for cupola practice. Combustibility can be defined as a measure of the speed with which the carbon present in the coke will unite with oxygen under the given conditions.

The following factors affect the combustibility of the coke used for metallurgical purposes:—(*a*) Influence of graphite coating or film on the pores of the coke; (*b*) volatile matter left in the coke; (*c*) porosity; (*d*) areas of internal surfaces of cells, and (*e*) character of cell structure.

Coke is known to be a fairly incombustible substance compared with, say, charcoal, and the incombustibility is primarily due to the fact that in the distillation of coal a film of graphite carbon is deposited in the coke cells. This film is caused through the breaking up of the volatile products of distillation in their passage through the hot coke in the coke oven. This film is not easily combustible, and prevents combustion of the coke substance to some extent, as it acts as a protection against solution by carbon dioxide. The amount of volatile matter left in the coke affects the ease of ignition only.

When dealing with the last three factors, it must be remembered that the structure of coke has been considered from three points of view, porosity, density and reactivity.

As will be shown later, porosity and density are reciprocal, and the ratio of relative volumes occupied by the coke substance and the "cells" in the coke is calculated from the specific gravities, but the porosity figure thus obtained gives us no idea of the areas of the internal surfaces of the cells.

For this information it is required to know:—(*a*) The size of the cells: (*b*) their number and distribution; and (*c*) thickness of coke walls between them.

The influence of the reactive surfaces within the coke mass, on combustion, has been understood to be a function of the porosity, as it was thought it was necessary to secure free access of the oxidising gases and free removal of the products of oxidation to obtain full advantage of the reactivity of the internal surfaces.

Necessary Properties.

Therefore, it can be said that the combustibility will be greatly affected by the cell structure of the coke; the dimensions of the cells, and the continuity of the cell structure, also exercising considerable influence.

Therefore, a foundry coke must have the following properties:—

Physical.—I., well developed cell structure; II., sufficient hardness; III., proper size; and IV., non-friability.

Chemical.—I., large carbon content; II., low ash content; III., low sulphur and phosphorus content; and IV., low moisture content.

Laboratory Physical Tests.

These tests include the determination of:—(1) real specific gravity; (2) apparent specific gravity; and (3) porosity.

The *real* specific gravity is determined by using a known weight of finely ground coke in a specific gravity bottle, the bottle being first weighed filled with water and again when containing the known weight of coke and water not displaced by it. Air bubbles in the submerged coke must be removed.

The *apparent* specific gravity is found by suspending a fairly large piece of dry coke by a fine thread from the hook of a balance pan and weighing first in air and then in water. The weighing must be accomplished as rapidly as possible to prevent the water displacing the air from the pores of the coke.

The porosity is obtained as a percentage from the formula:—

$$\frac{\text{Real Specific Gravity} - \text{Apparent Spec. Grav.}}{\text{Real Specific Gravity.}} \times 100.$$

Chemical Laboratory Tests.

These consist of the estimation of:—(1) Moisture; (2) volatile matter; (3) ash; and (4) sulphur. The tests for these will be found in most text-books on fuels.

The ash may be separately estimated for:—(*a*) Silica; (*b*) alumina; (*c*) iron oxide; and (*d*) phosphorus and other compounds and elements.

To many users of coke the constitution of the ash is an important matter, as when coke is used in furnace work the constitution of the ash determines the liability of the coke ash to form clinker, and, when used for metal melting, impurities are apt to be absorbed by the molten metal from the ash constituents.

Practical Methods for the Testing of Coke.

The crushing strength of coke is not a satisfactory test for its hardness when judged from the ironmaker's point of view, as he requires a coke which has not only a hard cell structure, but a coke which, although it may break up from the large lump to smaller pieces, will not crush down to small stuff and cause blocking of the cupola. At the present time there is no universally accepted method of mechanically testing coke, but certain tests have been proposed by interested parties in this country. Mr. G. D. Cochrane, Mr. G. Jones and Mr. G. W. Henson have each invented machines for testing the coke hardness.

The machine used by Mr. Cochrane, designed for him by Mr. Jones, consists of a drum with two angle bars fixed inside to turn the coke sample over. The sample to be tested weighs 56 lbs. in lumps up to the size of a man's fist. The sample is dried on hot plates for 24 hours, and 28 lbs. of the dried coke is placed in the drum, which is given 1,000 revolutions at the rate of 18 revolutions per minute. The sample is then sieved over a ½-in. mesh, and the quantity remaining on the sieve is stated as a percentage of the original 28 lbs., and is called the hardness of the coke.

Mr. Cochrane found as a result of his tests that the output of his blast furnaces fell as the "coke hardness" fell. When the hardness was between 74 and 76 he had very little trouble, but when the hardness fell below 74, the output of the plant fell considerably.

The "shatter test" has received a large amount of favour in the United States, being adopted by the Bureau of Mines, and is used to determine the relative breakage of the coke. It consists, usually, of dropping a known weight of coke on to an iron plate from a height of 6 ft. The apparatus consists of a box having a capacity of 100 lbs. of coke, mounted on supports, the cast-iron shatter plate being 6 ft. below the bottom of the coke box. Boards about 8 in. in height protect the edges of the cast-iron plate against loss of coke. The bottom of the coke box is provided with hinged doors which are held closed by a latch and are arranged to swing open freely, when the latch is released, thus permitting a free fall for the coke.

A sample of approximately 50 lbs. of lump coke is placed in the box, and the sample is dropped four times on to the cast-iron plate, the small material and dust being returned to the box with the large coke after each drop. After the coke has been dropped on to the plate four times, it is screened over a 2-in. mesh screen. The coke remaining on the screen and that passing through being weighed separately, thus determining the amount of breakage.

Carrick Anderson gave the following specification in terms of maximum percentages to be fulfilled by a coke employed for iron melting:—Water, 1 per cent.; ash, 9 per cent.; dust on delivery, 6 per cent.; phosphorus, 0.018 per cent., and sulphur, 1 per cent.

In addition there should be for blast furnace coke 40 to 50 per cent. pore space, or for foundry coke, 25 to 40 per cent., and hardness of 1,140 lbs. per sq. in., or 80 kgms. per sq. cm. The weight of 1 cub. cm. of the coke (dried at 100 deg. C.) should be 0.8 to 0.9 grs. (equal to from 13 to 14.75 grs. per cub. in.).

* Paper read before the Lancashire Branch of the Institution of British Foundrymen.

In 1915 the American Society of Testing Materials looked into the question of a foundry coke specification, and due to the difficulty of formulating definite standard specifications for beehive and bye-product coke covering a sufficiently wide scope, they decided to direct their work along four lines, including :—(1) Methods of sampling; (2) standard methods of chemical analysis; (3) standard methods of physical testing, and (4) standard specifications for foundry coke.

As a result, only tentative specifications for foundry coke were presented, owing to the wide variations in the chemical and physical requirements of the coke used for various purposes.

American Investigations.

Progress was made toward the adoption of uniform standard methods of analysis by co-operation with the joint committee on Coal Analysis of the American Chemical Society, and the Coke Analysis Committee of the American Foundrymen's Association, and uniform standard methods were expected to be available by the next year. Considerable attention to the various physical tests of coke were given by the committee. These included crushing strength, shatter test, porosity, specific gravity, etc., and the conclusion was arrived at that the compressive strength as determined on 1 in. cubes is worthless as a means of comparison, and that in general the relation between results of physical tests of coke and its value in practical use is too definite to include quantitive expressions of physical properties in standard specifications.

Thaler in 1915 made an investigation into the valuation of coke, and remarked that cokes for foundry and blast furnace use are differentiated in practice, but there is very little difference between them in reality. Coke for foundries should be the largest and best pieces, and as a rule, should contain less moisture and sulphur.

German Investigations.

A table showing the quality of coke required by the German Foundrymen's Association is given. This allows a moisture content of 5 per cent., which, in Thaler's opinion, is too high. The moisture content is largely dependant on the physical structure of the coke, a good hard quality being preferred as this carries less moisture than a softer coke. The phosphorous in the coke is almost entirely taken up by the iron, therefore, this should not exceed 0.04 to 0.05 per cent.

The physical properties as well as chemical composition should be taken into account in classifying cokes.

The principal points to consider are :—

(1) *First-class Coke.* Silver white lustre, sinewy structure, dense, firm with metallic ring, resistant to pressure, should not break into small pieces when falling, or contain more than 8 per cent. ash, 3.5 to 4.0 per cent. moisture and 0.8 per cent. sulphur.

(2) *Second-class Coke.* Faint white to dark lustre, structure more boney and porous, and less resistant to pressure than (1); should not contain more than 10 to 11 per cent. ash, 8 to 9 per cent. moisture and 1 to 1.1 per cent. sulphur.

Table I.—*Meissner's Table of Physical Tests for Blast Furnace Coke.*

Coke made from mixtures of American coals in proportions.	Shatter test.		Specific gravity.		Porosity or percentage of cell space.
	Through 2 in. screen.	On 2 in. screen.	Apparent.	True.	
80% Pocahontas 20% Ronco	15.6	84.84	0.976	1.841	47.03
80% Pocahontas 20% Ronco	16.11	83.89	0.950	1.824	47.92
60% Pocahontas 40% Ronco	14.06	85.94	0.992	1.834	46.31

(3) *Third-class Coke.* Lustreless, grey black, fracture, soft, breaking easily when struck; the individual coal particles are easily distinguished; highly porous and holds water tenaciously. It has a low density, 9 to 9.5 per cent. ash, 13 to 15 per cent. moisture and 1 per cent. sulphur.

Mr. C. A. Meissner gives as good physical coke tests for standard quality of blast furnace coke the figures set out in Table I.

Cupola Troubles in Relation to Coke.

The coke is sometimes blamed for cupola troubles for which it is not the cause such as :—(1) Defects in the practice of the operator; (2) excess of air due to too high blast pressure; (3) blocking up of tuyeres and (4) change in source of coke supplies without any modification in working of cupola to meet the altered quality of the coke.

A fuel, high in ash content, will give a greater unburnable residne, and thus cheapness in price may be more than discounted by the extra amount of coke required for melting, and the additional amount of slag resulting.

According to Mr. L. E. Gilmore, a consulting metallurgical engineer in U.S.A., malleable cupola practice requires a larger amount of fuel per ton of iron melted than does grey iron, due to the higher temperature required to run thin sections and to lower percentages of phosphorous and silicon. For the malleable range he gives a coke to iron ratio of from 1 : 4 to 1 : 5.5. Attempts to exceed 1. to 5.5 result in liability of dull iron. The amount of coke in the bed and between the iron changes must be so proportioned that the iron fuses high in the melting zone, producing iron of the required temperature and causing slower rate of melting than is the cause with grey iron when using less fuel.

The speed of melting can be increased or diminished within limits by varying the blast pressure, but large increases in blast pressure must be accompanied by additional fuel for the bed, as the melting zone is forced higher in the cupola. A 6 to 12 oz. pressure should give hot-melting but 16 oz. or over, shows excessive clogging of cupola by slag, or too tightly packed materials such as finely divided coke or scrap iron.

Coke Economy in Relation to Cupola Practice.

The heat generated is employed as follows :—(1) For melting the iron, fluxing the impurities and providing the extra heat necessary to enable the iron to remain sufficiently fluid for the moulder; (2) to compensate for the heat losses :—(a) Radiation from cupola; (b) sensible heat in waste gases, and (c) heat lost in unburnt carbonmonoxide.

To obtain economy in coke consumption it is necessary to cut down the heat losses to the smallest extent, although the coke consumption depends on other factors as well.

Radiation Losses.

These will be small compared with (b) and (c), but will be diminished by having a minimum of radiating surface in relation to output.

Sensible Heat in Waste Gases.

The gases leaving the combustion zone of the cupola will do so at a high temperature, and as much of their heat as possible should be taken up by the descending charge, otherwise, such heat is lost to the cupola.

In order to prevent as much of this loss as possible, maximum amount of contact between the charge and the hot gases per unit of time is necessary. Thus in high and narrow cupolas, the path of the gases is longer and their velocity greater, and according to Mr. H. J. Yates*, the relation of diameter to height should not fall below a certain figure, also, high and narrow forms of cupola are preferable for this reason.

Heat Lost in Unburnt Gases.

It is impossible to completely eliminate this loss entirely, but the causes of such loss should be examined and remedied. They are :—(1) Insufficient blast; (2) improper settling of charge due to broken linings or irregularities in charging and (3) faulty air distribution of air at tuyeres.

In the first case the trouble is due to lack of oxygen to complete the combustion process, and in the second and third cases, improper distribution of the air throughout the charge, with the possibility of the carbon monoxide being cooled below its ignition temperature in certain parts of the cupola.

It is well known that excess of coke not only reduces the economy of the plant, but will also affect the speed and regularity of the melting, and

*British Association Fuel Economy Committee.

therefore, experiments may be made with advantage in reducing the coke charge until the best results are obtained.

There are, of course, many other points by which economy of coke may be obtained, as by attention to the various constructional points in cupola design, and by the general methods of manipulation, which are the every day business of the foundry manager, but are outside the scope of this contribution.

APPENDIX.

Determination of Phosphorus in Coke.*

The determination of phosphorus in coke recommended by the American Foundrymen's Association is as follows:—

Five grs. of coke are ignited either in a platinum dish or large platinum crucible until all carbon is burnt off, after which 10 c.c. of 50 per cent. hydrochloric acid and 20 c.c. of hydrofluoric acid are added; the sample is then evaporated to dryness, and ignited at a dull red heat. The residue is fused with about 3 grs. of sodium carbonate and 0.3 gr. of potassium nitrate, cooled, and the dish containing the fusion is placed in a beaker of water and boiled. When the fusion has been completely dissolved, the dish is rinsed into the solution and then laid aside.

The solution is next acidified with hydrochloric acid, precipitated with ammonia, boiled, filtered and washed with hot water. The precipitate is dissolved by washing the filter with warm dilute nitric acid, but if it should not dissolve under this treatment, it should be washed with warm dilute hydrochloric acid until it does dissolve. If the latter operation becomes necessary the solution must be evaporated to a volume of about 5 c.c., after which about 30 c.c. of 1.20 sp. gr. nitric acid is added, the solution is again evaporated to about 5 c.c. and 30 c.c. of nitric acid (1.20 sp. gr.) is again added. The solution is now heated to between 70 deg. C. and 90 deg. C., and 50 c.c. of molybdate solution is added: this solution is stirred for a few minutes, filtered and washed 5 times with a 3 per cent. nitric-acid solution, and 5 times with a 0.1 per cent. potassium nitrate solution. The precipitate and filter is now transferred to the flask in which the precipitate was made.

Here 30 c.c. of water are added, followed by a $\frac{N}{5}$ solution of sodium hydroxide from a burette until the latter is in excess, the solution being constantly agitated. After the yellow precipitate has been entirely dissolved 0.1 c.c. of phenolphthalein solution is added as an indicator, and the result is then titrated with $\frac{N}{5}$ sulphuric acid.

The following calculation will then give the percentage of phosphorus present:—

1 c.c. of $\frac{N}{5}$ NaOH = 1 c.c. $\frac{N}{5}$ of H_2SO_4 × 0.0054 = percentage of phosphorus.

The molybdate solution is made by adding 100 gr. of molybdic acid to 250 c.c. of water, after which 150 c.c. of ammonia is added, this mixture is then stirred until all is dissolved, after which 65 c.c. of nitric acid (1.42 sp. gr.) is added. Another solution is now made by adding 400 c.c. of concentrated nitric acid to 1,000 c.c. of water; both solutions are allowed to cool, and the first solution is then slowly poured into the second, constantly stirring the mixture, after which a few drops of ammonium phosphate are added.

* From "Coal and Coke," by Wagner.

The Design and Construction of Runner Heads.

By M. J. Cooper.

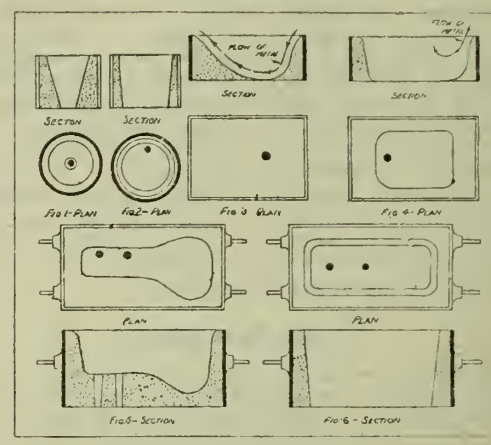
It would be safe to say that more castings are spoiled by careless pouring and badly-designed runner heads than by faulty metal or defective moulds, and the majority of burning accidents may be traced to the same source.

Having decided the best situation for the pouring or runner head in relation to the crane and general surroundings, the form and size the runner head shall take must then be fixed upon This will be governed more or less by several circumstances; the position of the down-gate on the moulding box, the weight of the casting, and the area of the runner, also the size of the ladle to be employed.

However well-constructed a runner may be, if it be so placed about the down-gate that the metal may form a vortex or whirlpool, as in Fig. 1, there is a grave risk of dirt entering the mould along with the metal at the time of pouring. The action and effect of a whirlpool in relation to casting or pouring may find fitting demonstration by observing the water passing down the waste pipe from the bath or wash basin, and any form of circular runner head is a source of danger unless considerable care is used when pouring, but a circular runner head made and placed about the down-gate, as shown in Fig. 2, is acceptable.

A runner head should never take the form of a saucer or basin, and it is bad practice to have the down-gate occupy the centre of the runner head, or for it to be placed directly under the fall of the metal when pouring (see Figs. 3 and 4).

When constructing a runner head, the retaining walls of sand should be as vertically straight as possible, and it is an advantage to make them



slightly undercut. A runner head should never be harder than a mould. A hard-rammed runner will cut and scab just as freely as a mould similarly made.

Once pouring commences, the runner head should be filled as quickly as possible, and, when filled, it should be kept at a constant level until the metal appears in the risers.

With a properly-made runner head and the ladle in competent hands, splashing of metal should never occur, and it may be truly said, "with much splashing, there is much waste and many wasters."

It is frequently seen with the first entry of the metal into the runner head a spray of shots, then a pause in the pouring, to make sure all is well personally, and as frequently a succession of splashes and pauses, so that the mould has been filled by a series of splashes instead of being truly poured, and neither skimmer nor skimming-gates under these circumstances will prevent dirt entering the mould along with the metal.

This state of things may be brought about in several different ways: the runner head may have been moulded in the form of a saucer, so that the metal is "switchbacked" over the opposite side, or the bottom of the runner is so placed that the metal drops where a flat-rammer has left its firm impression, or the damp bar of the top box has been left exposed, in which case further trouble is likely to follow, for the molten metal may melt and adhere to the bar when cool, to the consequent damage or destruction of the box part, for, if not actually adhering, the concussion of breaking the head when cold will break the bar.

Endeavour at all times to restrict the size of the head; in other words, design a runner head for utility and economy (see Figs. 5 and 6), and when placing a runner or runners at the onset of the job, try to visualise the form and size of the runner head necessary. It will then be known almost from the commencement of the job exactly the runner box required, and, within reasonable certainty, where to lay hands upon it.

The Steel Foundry of Messrs. Thwaites Brothers.

Any description of this old-established Bradford engineering works must be read bearing in mind that it is situated in a congested area, and no opportunity is afforded for including all that is best in modern lay-outs. In such works, however, great ability can be shown in the devising of labour-saving mechanisms of an original character, and it is in this direction that the Vulcan Works prove so interesting.

The steel foundry has been laid out primarily for the manufacture of repetition castings, but specialising in motor-omnibus and lorry wheels.

The Foundry Proper.

The foundry itself is housed in three bays, each being 160 ft. long by 35 ft. wide. It is provided with one 5-ton and six 2-ton Morris electric overhead cranes. Liquid metal is supplied by three 2-ton single-phase Snyder electric furnaces. A full description of this plant was given in a Paper presented to the West Yorkshire Metallurgical Society by Messrs. H. P. Abel, A. A. Liardet, and W. West, and was reproduced in our issue of June 1, 1922. A point, however, which was not mentioned in the Paper was that the furnaces are provided with slagging notches, which effectually keep back the slag and allow of the use of lip-pouring ladles, whilst still ensuring castings free from slag inclusions. For some work, however, the bottom-pouring ladles are still utilised.

Reception of Materials.

For such a plant the chief raw materials are steel turnings of good quality, on account of the furnaces being acid, slag-making materials, alloys, and sands. Being very strong advocates of scientific control, nothing is left to chance and all raw materials are examined both chemically and physically. Two laboratories, under the care of Mr. W. West, tackle this problem systematically, as any laxity only provides more work at the other end of the scale, as the finished castings or test pieces from them are subjected to chemical analysis, heat treatment, and mechanical testing.

The Physical Laboratory.

This department is equipped with a 30-ton Buckton testing machine, which can be used for ascertaining the tensile strength of steel and the crushing and transverse strength of cast iron. The useful Brinell, a Foster impact, an Avery concrete tester for ascertaining the mechanical strength of cores and refractories are not merely installed but are constantly in use, as is evidenced by the large number of daily results shown to our representative. In an adjoining room a Swift microscope provided with an optical bench for photo-micrographic purposes is installed, whilst another bench supports a Cambridge recording pyrometer, which at the time of our visit was recording the thermal history of four annealing ovens.

The Chemical Laboratory.

This is a white-tiled, roomy department. It is divided into three sections—the laboratory proper, the balance room, and, what is of equal importance, the library and conference room. To the last the melting shop and foundry foremen have full access, and it is here that the co-operation of the technical and practical staffs takes effect by weekly conferences. The actual laboratory is in every respect modern. It is well designed, and the chemists enjoy immunity from the smells associated with steel analysis by an excellent system of ventilation.

Fig. 1.—Transporting Crushed Turnings to the Melting Plant. Messrs. Thwaites Brothers, Limited, Bradford.

Transport of Turnings.

As pointed out, the Vulcan Works is situated in a congested area, and this factor prevented the unloading of the turnings in close proximity to the furnaces. They arrive some distance from the melting shop, and are crushed in a pug mill in order to allow of their being more easily charged into the furnaces—a very advisable practice. They are then transported by an aerial ropeway, illustrated in Fig. 1, to a convenient situation beneath the melting shop.

Preparation of Sands.

Messrs. Thwaites realise the importance of standardising sands, and the first step taken is

to dry all new sand in a drier of their own design. This is of the rotary kiln type, and is illustrated in Fig. 3. The facing sand is prepared from a mixture of "Yorkshire" and Mansfield.

Core Shop.

A view of this shop is given in Fig. 4. It is entirely staffed by women coremakers. Oil-sand cores predominate, and are made up with the

Fig. 2.—The Melting Plant, consisting of Three 2-Ton Snyder Furnaces. Messrs. Thwaites Brothers, Limited, Bradford.

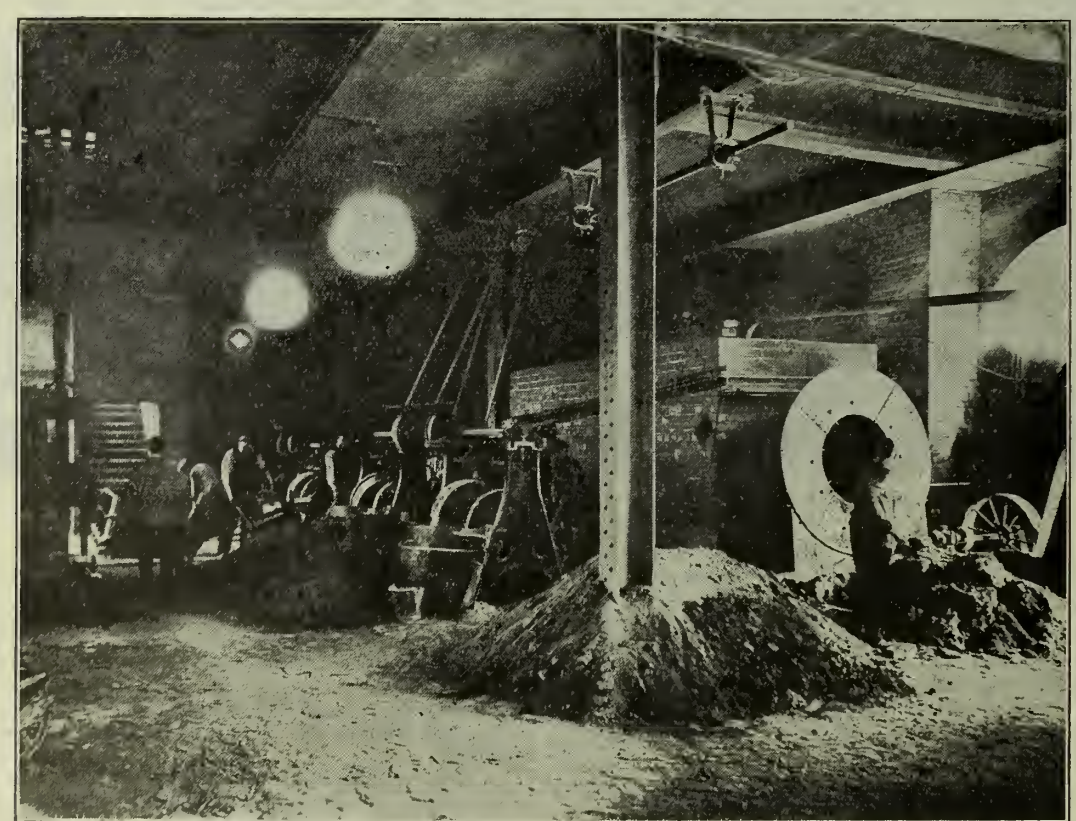


Fig. 3.—Sand Drying and Preparing Plant. Messrs. Thwaites Brothers, Limited, Bradford.

Moulding Details.

The wheel-moulds are made on 12 "Britannia" jar-ramming machines. Additionally there are 8 hand ramming turnover machines. The majority of moulds are skin-dried by means of town's-gas-fired burners. There is, however, an externally-fired mould-drying stove to cater for larger work.

Fordath preparation as a binder. The mixture is maintained at an elevated temperature to ensure the necessary fluidity to enable each grain of sand to be equally coated. Amongst a variety of core-making machines our representative particularly noticed the one illustrated in Fig. 6. It is a simple arrangement made by the firm, and turns

out half-cores on boards ready for drying. The core stoves used are more substantial than those usually employed, being of brick construction. They are coal-fired, and some are arranged to take bogie wagons.

Spinning Bushes.

By the side of the melting furnaces an interesting centrifugal casting plant has been installed. This arrangement has been entirely successful, but expansion to a mass-production is problematic

Fig. 4.—General View of the Core Shop. Messrs. Thwaites Brothers, Limited, Bradford.

Fig. 5.—One of the Three Bays of the Foundry. Messrs. Thwaites Brothers, Limited, Bradford.

Heat-Treatment Plant.

This department contains three large annealing furnaces; two are by the Incandescent Heat Company, which have been modified to meet the special conditions obtaining, and a removable roof has been incorporated to facilitate charging. A third is of the reverberatory type. All are pyrometrically controlled from the physical laboratory.

owing to the difficulty of maintaining hot a reservoir of liquid steel on which to draw. The machine is initially rotated at 400 r.p.m., and is increased to 1,000. We have elsewhere stated that, with the exception of alloys containing two ingredients of very divergent specific gravities, centrifugal casting is beneficial. Our representative was shown a bush made from a mild steel of

approximately the following composition: C, 0.08; Si, 0.04; and Mn., 0.08 per cent. This steel, if poured normally, would have given a honeycombed ingot or casting, but which, when spun, made a quite solid bush of exceptional softness. The chills into which the liquid steel is poured, are made of hematite iron and last several hundred heats, after which they deteriorate through pitting.

General.

As stated, a speciality is made of lorry and omnibus wheels, and this specialisation does not stop at the foundry. The fettling shops, which are replete with sand-blast apparatus, have many arrangements specially devised to facilitate mass production. In the large modern machine shops solely devoted to the production of wheels, the hub centres are broached instead of being turned.

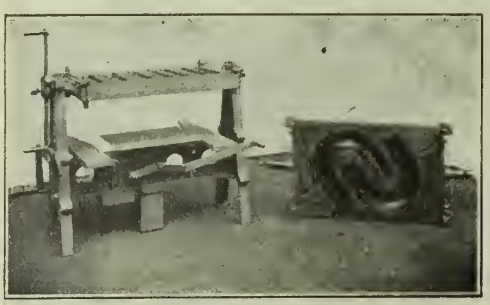


Fig. 6.—A Core-Making Machine. Messrs. Thwaites Brothers, Limited, Bradford.

Spraying machines are used for painting purposes previous to despatch.

Welfare Department.

The works possesses an excellent dining-hall, which is much appreciated by the operatives, whilst a modern ambulance room is under the constant care of a trained nurse. It is interesting to nofe that the dining hall is utilised as a lecture theatre for the instruction of both adults and apprentices. The interest which Mr. Liardet, the managing director, takes in the apprenticeship question is well known.

Importance of Temperature in Bessemer Converters.

The German metallurgist, Herr Otto Holz, of Oberhausen, has recently called attention to the influence exerted by the temperature of the metal, when eharged into the converter, on the behaviour of basic pig-iron during the blowing process. It is a well-known fact that the blowing of charges is always more troublesome after the week-end rest, when the metal in the mixers has a tendency to become cold than when, with the work in full swing, the mixers are barely able to meet the demands of the converters. Dissenting from the opinion that certain difficulties in working were due to the chemical composition of the iron, Herr Holz maintained that the trouble was most often due to greater viscosity of the metal consequent upon its low temperature. In support of his contention, he adduces the experience gained at the Kladno Works, where an iron containing Si up to 1 per cent., Mn 0.1 per cent., P 2-2.4 per cent., and S 0.06, was blown without any trouble before the war, and the experienco at the Neuenkirchen Works, where a pig-iron with the analysis: C about 3 per cent., Si 0.28 to 0.35 per cent., Mn 0.1 to 0.14 per cent., P 1.75 to 1.85 per cent., S 0.08 to 0.12 per cent. was equally satisfactorily dealt with. In both these plants the iron was, owing to special conditions, poured into the eonverter at a very high temperature, and the resulting steol was of first quality and could be used for the manufacture of wire and woldless tubos.

Herr Otto Holz, from his own praetical experience and from a study of the results communicated to him by other experts in basic Bessemer works, concluded that it was possible to blow, with excellent results, irons having widely different chemical compositions, including oven thoso formerly considered unsuitable for use in converters, provided that the metal was made very hot. He has proved that if a metal is viscous owing to its low temperature, even if high in Mn and particularly if high in Si, the blowing timo may bc prolonged by three to eight minutes; that the slag may contain from 12 to 14 per cent. of iron, and that the risk of ebullition may become so serious as to require a reduction in the usual blast pressure. For a metal of similar composition, but very hot, on the contrary, the duration of the blow may be reduced by 20 to 25 per cent., and is, consequently, under perfect control, the risk of ebullition is almost nil and the iron content of the slag is easily kept down to from 8 to 10 per cent. In consequence of this experience the author is inclined to consider the question of sensible heat of such importance, from the point of view of economy, that, making due allowance for the extra cost of the operation, he deems it worth while to allow the molten metal to remain a short time in an open-hearth furnace, in order to allow it to acquiro the extra 50 degrees or so before charging it into the converter. It is just this small difference in the temperature (between 1,190 to 2,000 deg. and 1,250 to 1,260 deg. C.) which Herr Holz considers sufficient to make all the differenee between a "physically hot" and a "physically cold" metal.

A French Criticism.

M. Andre Cornu-Thenard has the following comment on this in a recent issue of the "Revue de Métallurgie":—

The views propounded by Herr Holz on this subject have aroused a keen interest among steelmakers beyond the Rhine as proved by the number of speakers who have taken part in the discussion and their repute in the steel industry. In France the Compagnie de Chatillon, Commentry and Neuves-Maisons, has carried the matter even farther, and, following upon the experimental work done by M. Kerschen, the engineer at Neuves Maisons, patented in 1919 a process ensuring the supply in regular working of a very fluid hot pig-iron low in Si and Mn, and giving, in the converter, results equal and sometimes even superior to those obtained by Herr Holz. The process adopted at Neuves Maisons and used now for several years results in considerable economy in manganese, and is briefly as follows:—The iron, made in the blast furnace in accordance with the patented process, is passed into a mixer of 600 tons capacity, fired with blast-furnace gas. On leaving the mixer the composition of the iron is about as follows:—C, 3.25 to 3.40; Si, 0.30 to 0.45; Mn, 0.5 to 0.7; P, 1.90 to 2.00; S, 0.040 to 0.070 per cent. It is then charged directly into a converter at a temperature of nearly 1,300 deg. C., and blown from 10 to 12 minutes, the blast pressure being about 25.5 lbs. per sq. in. at the beginning; this is quickly increased up to about 31 to 35.5 lbs. per sq. in., at which pressure it is maintained till the finish. The average iron content of the slag is about 7.70 per cent.; that of manganese does not exceed 3.5 to 4.00 per cent., whilst the loss by ebullition during the blow is extremely low.

German Iron and Steel Industry.

The open-hearth steel plant at the Peine rolling mills is shortly to be shut down owing to the high cost of English coal, upon which the plant is dependent.

Negotiations are proceeding between 52 works of the railway wagon construction branch for the formation of a syndicate, and a decision is expected to be reached this week.

The French Group which was formed to acquire 15 per cent. of the share capital in the Silesian Hohenzollern Works, is reported by the Polish newspapers to have exercised an option on a further 15 per cent. of the shares. The Group was constituted by members of the Comité des Forges in their private capacity, and these are also said to be interesting themselves in the Kattowitz Company, and the Königs and Laura Works. Franco-British companies are also declared to be in process of formation in Paris with the object of developing Upper Silesian works.

Mr. Harris Abrahams, Mansell Street, E.1, has established a tinplate and metal department at 4, New London Street, London, E.C.3.

Defects in Brass Tubes.

At a meeting of the Birmingham University Metallurgical Society, held at the University on October 31, some important conclusions and suggestions based on works practice were given in a Paper entitled "Some Defects Occurring During the Manufacture of Brass Tubes," by Mr. W. E. Ballard. Confining himself to 70:30 tubes, the author dealt with failures as classified under three headings: Faults of Castings, Faults of Annealing and Faults of Drafting.

Casting, Mr. Ballard said, was a process which could be very productive of failures, and it was sometimes blamed more than it deserved. The inside surface of the tube casting depended largely on the suitability of the core and the outside on that of the mould and its dressing, whilst the wall of the tube would be prey to all the ills inherent in solidifying metals. Obviously a tube would be useless if any of the sand of the core crumbled away and became entangled in the metal or if the metal ran through the core. It was surprising how few tubes suffered in such a way, but the trouble when it did occur might be due to too little binding material being used in the sand mixture, or to the cores having been dried at too high a temperature, perhaps in the neighbourhood of 150 deg. C., in which case they would almost always show cracks before being placed in the mould. Another cause might be rough handling after leaving the stoves. Roughness due to the molten metal biting into and fritting the sand usually occurred at the place where the metallic stream impinged upon the core. To prevent this the cores were dressed before their final drying with a wash usually of powdered charcoal in a weak solution of binding material. Large holes in the tube were usually due to badly-dried cores, or to a spot of water having fallen on the core just before it was placed in the mould. It was unnecessary to point out that under-drying of cores might lead to serious accidents. Core troubles might be overcome completely when a satisfactory steel or metallic core could be introduced.

Mould Dressings.

In considering defects of the outer surface they came to the vexed question of mould dressing. Very little work of a scientific nature had been done on this subject. Mould dressings for tubes usually had two components, (*a*) an oil liquid, and (*b*) a thickening medium. The latter was usually finely ground charcoal, graphite or anhydrous clay. Probably charcoal was the most generally used. Graphite was slightly more expensive, but was inclined to make the moulds dirty. Dehydrated clays needed very careful attention. Clays had a tendency to pull together and to give uneven coatings on the moulds. Small clay particles were also apt to get trapped in the metal. It was with regard to the oil base that one found the great difference of opinion. Weird and wonderful were some of the mixtures used. It was a common thing to find as many as four oils combined in the dressing. A dressing recommended to him consisted of Russian tallow, lard, or a substitute, seal oil, a little beef tallow, a pinch of resin and charcoal. Whatever oil is used as a base it would need a certain proportion of thickening matter. If the mixture was too thick the casting would have a peculiar wavy surface resembling a crocodile's skin. If still thicker, large black marks resembling thumb prints would be seen. If the mixture was too thin the casting freshly taken from the mould would be a bright golden colour in patches, and the surfaces of these patches would be honeycombed with small holes. The question of the influence of the oil base brought up another thorny subject, namely, mould temperature, as to which the practice of various works was widely divergent, the temperatures varying from 100 to 300 deg. C. If the mould was too hot, the surface of the casting was similar to that found when the dressing was too thin, and if the mould was too cold the surface of the casting showed dirty patches and was slightly corrugated. The use of lard-oil substitute or lard oil itself demanded a cool mould, certainly not above 150 deg. C. Seal oil and cottonseed oil also needed cool moulds, though a higher temperature might be attained if a little resin was added. Too much resin gave the casting a shiny, hard bluish surface, and the mould gradually became covered with a hard metallic skin. Personally he thought it better to use an oil base which gave the biggest latitude of mould temperature, and mineral oils of high flash point undoubtedly had this advantage. It had been suggested that oils of high viscosity at 150 deg. C. might be best for dressing purposes. But the ascertained viscosities of the common oils used in dressing showed that this property was not essential, otherwise castor oil with a viscosity of 390 deg. compared with the 100 of whale oil would make a wonderful dressing. The specific gravity also seemed to be a negligible factor, but either the flash point or the temperature of spontaneous ignition in oxygen did seem to give a fair indication of suitability for dressings. Tar and bitumen were quite good for dressings for heavy castings with a good body of metal, but their partial combustion left a good deal of dirt. Therefore, heavy mineral oils seemed to be as satisfactory as anything.

Internal Defects and Pouring Temperatures.

Internal defects in the tube wall were the most difficult to discover and to cure. At Muntz's Metal Company's Birmingham works great care was exercised to avoid faults of this nature. Every day sample castings were taken and burst by being expanded on plugs. The fractures were examined carefully. Another system used there was breaking up castings under a power hammer. He thought bursting by expansion was probably the best method, as fracture then occurred down the line of maximum defects. A tube so fractured often proved to be generally porous. Holes were seen all over the fractured surface, some dirty and some with a shiny internal surface. The only possible cause of such a bad defect was too low a pouring temperature. In 1920 Mr. Bamford and himself, in a Paper before the Institute of Metals, asserted that porosity of this type was found only in a tube cast below 1,150 deg. C. This statement was severely questioned on the ground that tubes cast a little above that temperature were usually burnt. Since that time he had seen many hundreds of tubes fractured, and he still did not understand the meaning of the expression "burnt tube." It was impossible to cast a brass tube much above 1,200 deg. C. owing to the rapid volatilisation of zinc. Since pyrometric control had been initiated at Muntz's this class of porosity had vanished entirely. It was a definite fact that high casting temperatures might give very slow cooling in a large billet, giving rise to large crystals and planes of weakness, but the annular space in which a tube was cast was too thin to allow of very slow cooling. Therefore, he was confident that brass tubes could not be spoiled by overheating within reason, although he was prepared to admit the advisability of casting billets at a slightly lower temperature. Another proof of the beneficial results of high pouring temperature was given by the mode of fracture of tube castings on the expanding plug. If the casting was sound but had been cast at a fairly low heat, the expander would rip the tube open in a straight line; but if the tube was correctly cast more power was required for fracture, which took place along a sinuous curve. It might be noted that if the metal was embrittled by any impurity, the expanding tool cracked small rectangular pieces from the casting, giving a tesselated effect.

Speed of Teeming and Slag Inclusions.

Another defect shown on fracture might be a slight porosity and general dirtiness of the tube walls. On examining closely many non-metallic inclusions could be seen. This class of defect was usually due to making the casting too thin for its length. Cutting down wall thickness to its limit to save drafts had been the cause of many toolmakers' troubles. If castings were made too long a similar defect was seen. A few black holes in the middle of the casting were usually a sign of too rapid pouring and the trapping of air in the mould. This was the cause of many

"spills" in the finished tubes. Too slow a pouring rate would cause intercrystalline cracking, usually accompanied by a corrugated surface. Slag inclusions and charcoal inclusions were due to imperfect skimming of the molten metal, the former usually had the shape of an inverted pear and might be black or pale green in colour.

Annealing Defects.

Defects of annealing fell under three heads, (1) insufficient annealing, (2) overheating, (3) fire cracking. The first two classes of defects, though obvious, must be referred to. In many tube works pyrometric control was unknown, and however experienced a man might be, he would not anneal all tubes perfectly. It was common practice for the mouth of the furnace to be shaded from the light so as to enable the man better to judge the temperature. The natural result of such crude methods was that tubes tended to be burnt in the bright days and under-annealed in the dull days. A good, red temperature was considered by many evidence that the tubes were annealed. If the coal was good and the furnace flame fierce the tubes quickly attained to this, but no time was allowed for re-crystallisation. Every annealing furnace should have its pyrometer and, if possible, a recorder, too. An under-annealed tube was dangerous in the tube mill; the fault could not be detected till the tube was on the draw-bench when it required more power. If the tube itself did not break off the mandril might part, and with worn machinery an accident might result. Overheating, of course, was more easily detected, as the annealed tube then usually showed a yellowy green bloom due to oxide of zinc. Such samples were sometimes so full of intercrystalline cavities that they broke when dropped on the floor. Their fracture sometimes showed very coarse acicular crystals. Such tubes seldom stood up to the test of the draw-bench. Local overheating sometimes caused a weak area in otherwise good tubes. It was in detecting underheating and overheating that the microscope was most generally useful in a tube works. Sections at right angles to the direction of drawing were usually the most instructive.

Drawing Defects.

With regard to defects of drawing, he would pass over mere mechanical details affecting the appearance or gauge of the tubes and would refer chiefly to the effect of drawing on the stability of the finished tube. Such a discussion centred about the production and distribution of stresses in the tube. There were really only two methods used in drawing a tube; one, known as "hollow sinking," was for reduction of diameter without reducing the wall thickness, though it might result in a slight thickening of the walls or a very slight reduction according to circumstances. Reduction in internal diameter was known as sink. The other process, the reduction of wall thickness, was accomplished by supporting the tube inside with a bar or plug. Such reduction he would call "pinch." Of course, the usual "draft" was a combination of these two methods. In a Paper by Mr. R. H. M. Vawdreg and himself, read before the Faraday Society, he described the results of some experiments on 70:30 brass tubes. A tube which had been "hollow sunk" was well known to be liable to fire-cracking and season-cracking, and therefore must be in a state of internal stress. A tube was made from a well-annealed sample 1¾ in. × 1½ in. by drawing through a die 1-29-64ths bore. This corresponded to a sink of approximately 9/32nds in. The tubo after drawing was perfectly straight, but after lying on the laboratory table for four days the piece, 3 ft. 6 in. long, had deformed ¼ in. from the straight. This was evidently due to longitudinal stress. But great though the stress must havo been, it was small compared with the transverse stresses because the rupture of such tubes always occurred in a direction parallel to the longitudinal axis. Another curious phenomenon in connoction with hollow-drawn tubes or any tubes having high internal stresses was their behaviour when treated with mercurous nitrate solution in various ways. Tho intonsity of internal stresses could be roughly gauged by the time taken for cracks to develop when the stressed article was placed in snch a solution. When the outside of a highly stressed tubo was treated with the solution, cracks developed as quickly as if the tube were immersed completely. If the inside were so treated, cracks might not develop for several days. A tube that had been made by a reduction by pinch alone would not crack at all in such a solution; it would not fire-crack or season-crack, however much there had been put upon it. Tubes which had been subjected to pinch and sink might or might not crack, according to which effect predominated.

Obviously if in a tube mill it was the practice to sink tubes, season cracking would occur in the mill stock and fire cracking in the annealing furnaces. A defect more difficult to explain was stratification or lamination. It was primarily suggested that the cause of this failure lay in the casting department, but after much careful experiment it was definitely proved that this assumption was not tenable. A series of experiments was conducted to see whether it was possible that laminations could be caused by drawing. The explanation could not be given definitely, but it appeared probable that in the wall of a hollow sunk tube the circumferential stresses were concentrated near the surface. It was found that removal of both the skins tended to give a tube of greater stability, whereas the removal of the inside layer only tended to disturb the equilibrium. The difference of behaviour of the inner and outer skins was accounted for by the resistance offered by a hollow circular solid to any reduction in internal diameter. An examination of the microstructure also supported the theory. Experiment disposed of an alternative suggestion that the skin at the outer edge was really acting as a support and not as a highly stressed area. The conclusion was that the correct method of drafting was to combine pinch and sink. So well did these suppositions fit in with practice that, having worked out a system of balance for the drafts of all tubes manufactured, they had been able to make bad tubes to order with a remarkable degree of success.

Having given an account of a suggested method of differing potential in the study of the drafting of tubes, Mr. Ballard dealt with the final methods of testing tubes in the works. The roughest method, but the one generally used, was the sighting bench, the tubes being examined by looking down them on to an illuminated white plate. Another standard method was by means of the hydraulic pump. Under an internal pressure of from 1,000 to 1,200 lb. per sq. in. any small porosity or hole in the tube wall would burst. This test was used especially for condenser tubes. In the bulging test, by means of conical plugs a fair average was to say that the ends of the tubes must stand bulging to 25 per cent. increase of diameter. A further modification of this test was the flange.

The much-discussed low temperature annealing had been recommended with a view to prevention of season cracks and as an aid in the prevention of corrosion. Its usefulness for the latter purpose the author was not at present prepared to discuss, but to his mind it was an uneconomic method of preventing season cracking.

Miguet Process for obtaining Alumina from Clay.—A good grade of clay contains from 30 to 40 per cent. of alumina, and M. Paul Miguet, in the U.S. patent granted to him, proposes to prepare an alkaline aluminate by fusing clay, lime and scrap iron with a reducing agent in the electric furnace. The sodium aluminate thus obtained readily yields aluminium hydroxide while the ferro-silicon should be a profitable by-product. So many reactions similar to the above have been proposed, and it is so popularly believed that alumina can be obtained from clay by fusion that the U.S. Bureau of Mines undertook to investigate the process. The results are recorded in "Reports of Investigations," Serial 2,393, by Messrs. Clyde E. Williams and Clarence E. Simms. Analysis showed that 40 per cent. of the silicon had been reduced and alloyed with the iron. About 30 per cent. of the alumina was recovered. However, the prospects of a successful commercial application are extremely poor, as under the most favourable test the cost of material alone would be more than $300 per ton. Moreover, there is no proof that calcium aluminate was formed.

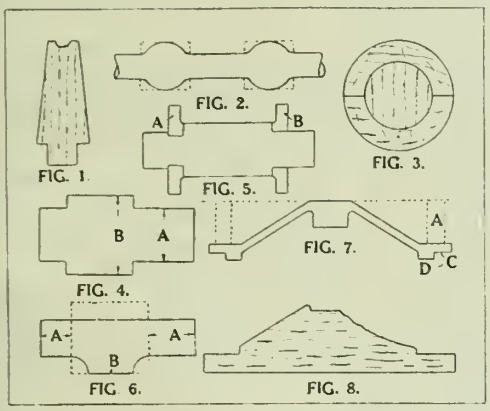
An Apprenticeship Course in Foundry Practice.—XIX.

By Ben Shaw and James Edgar.

LATHE WORK.

In some patternshops jobs of small diameter and of great length are common. It is necessary to turn them at fast speed, and yet, when the lathe is run at a fast speed, the vibration is excessive. If the diameter varies in such work, the largest diameter should be turned first—after the preliminary roughing-down—but the first operation should really be to turn a short distance in the centre to support a "steady." The steady may consist of a thick block of wood cut at the bandsaw to fit into the lathe bed and gouged at the top end to allow the work to turn in it (Fig. 1), or it may be a more elaborate device with a cover. The diameter which runs in the improvised bearing must not be a finished diameter, and it is usually necessary to finish with the plane at the bench. A very common job of this kind in ship patternshops are deck rails and stanchions (Fig. 2). In turning such a job the large bulb diameters would be turned first, centres carefully marked, the small diameters then turned, after which a template would be used to finish off, the ends of the template, which would have a centre line to correspond with those on the job, resting on the small diameter.

Wooden centre plates should be fixed on cylindrical work, so that the grain will run as shown at Fig. 3. This reduces the danger of the plate splitting on the joint line of the pattern. For either wooden or iron plates thick screws should be used, and they should have at least a grip of 1 in.



Cylinders of Two or More Diameters.

When turning cylindrical work of small size from solid timber, it is customary to get the rough block out to the largest size and turn down, but this would be wasteful in the case of lagged barrels. Not only would it be wasteful of timber, but it would cause the work to be much heavier, when first placed between the centres, than is necessary. Let us suppose that a barrel has to be made 12 in. dia. at A (Fig. 4) and 15 in. at B. If the staves are planed concave and convex, and fitted on circular grounds, it is quite a practical job to build the staves for the large diameter before the work goes into the lathe, but, in most pattern-shops, barrels that are going to be turned are not built in this way, and, in some cases, it may be a real advantage to turn the smaller diameter first and fit the top staves on in the lathe. Usually, however, as in the first-mentioned case, it is quicker to do all the building before starting to turn; it is a question that must be answered according to circumstances and according to the machine equipment of the shop.

Another point which may be worth mentioning here is the fitting of flanges and leaving unturned parts of a cylinder body to which branches have to be fitted. Unless, when there is a probability of alterations, a much superior job is made by setting flanges in, as shown in Fig. 5 at A. When they are fitted on the print diameter, as at B, they are very easily moved out of position; indeed, if the flange warps, it becomes locked in the mould. Some patternmakers turn flanges on a faceplate, but a better result is obtained by turning them on the cylinder body, which should be left slightly larger than the required diameter until the flange has been fitted.

At Fig. 6 is shown a cylinder to which a branch has to be fitted which is joined to the main body by a fillet. Considerable skill is required to make a satisfactory job in a reasonable time. Some men would very carefully centre-line the block and plane the face (B) square with the joint, and trust to accurate setting of the centre plates. It is better, however, to leave the centre portion balanced, as indicated by the dotted lines, and especially so if the job is long. In any case, the face should not be finished until the work has been taken back to the bench. The tendency of the times is to eliminate carved fillets wherever possible, substituting plastic-wood, leather, or wax fillets, but there can be no gainsaying the fact that, for branch work such as we have been considering, the carved fillet is much superior.

Using the Hollow Mandrel.

For turning special dowels and other small jobs the hollow mandrel makes a very good chuck. There are small parts which are too small to be turned with safety between the centres, but sometimes a piece of tapered timber can be forced into the hollow mandrel and the work turned at the necessary high speed. If it is long, the cone centre may be moved up to steady it. Another means of chucking is by means of a centre-screw in a small iron faceplate; this is very useful for turning small bosses. The paper-joint for very thin, delicate work is quite safe and satisfactory, but it is not as convenient as screws or sprigs.

Face Plates.

As a part of the equipment of every lathe there should be an assortment of wooden faceplates. In the use of faceplates much waste occurs. When reversing work, a faceplate will be frequently spoilt by turning deep recesses from its face, when a few small segments on the face to take a projecting spigot or boss would serve the purpose equally as well. Faceplates up to 12 in. dia. should be made from solid timber about 1 in. to 1½ in. thick. Above this size they should either be in two thicknesses, crossed or well battened on the back. If the faceplate is not quite rigid, the most highly skilled turner cannot turn out good work.

We shall suppose that a valve cover similar to Fig. 7 has to be turned. It is invariably advisable to turn the inside of a faceplate job of this kind first, because there will be more "spring"—it is not exactly vibration—when the timber is reduced in thickness, and there is great possibility of the tool tearing the work on the inside than on the outside, because one has less control over it. After the faceplate has been skimmed—it is necessary to straighten wooden faceplates very frequently—blocks must be screwed to it of a parallel thickness. It should not be necessary to turn these blocks on the face, as the inside is being turned first, but it would be necessary to do so if the outside had been turned first. The blocks should be curved, and may be three or four in number. They are indicated by the dotted lines at A (Fig. 7). When they have been screwed to the faceplate, the rough pattern may be screwed to them from the face.

The proper template for such a job is shown at Fig. 8. A full template is not advisable, because, with the greatest care, there will be slight discrepancies between the two sides; further, if the template is applied when the lathe is running, it may be broken. It will be noted that the faces A, B and C are turned without the template. This is a pattern that can be completely built before turning is commenced, but, in many cases, owing to the great depth, it might be difficult to get a rest close to the work, and it would be better to build part of the pattern, turn this, then complete the building, when the remainder could be turned.

Reversing is necessary with the valve-cover pattern, and segments can be sprigged or screwed to the faceplate and turned on the face and inner diameter to take the spigot on the cover, which can then be screwed from the back of the faceplate. A half-template would again be used, and either the centre used as a guide or the outer periphery of the cover, which would have been turned before the pattern was reversed.

Use of Turning Tools.

We shall consider briefly the actual use of woodturning tools now, but it can be stated at once that, when a few elementary principles have been mastered, only experience will develop skill. The apprentice is advised to seek opportunities for acquiring skill. An essential difference between pattern turning and ornamental turning is that, for the former class of work, scraping tools are frequently employed, while in the latter class of work cutting tools are used. Sometimes the reason for scraping tools being used by patternmakers is attributed to their lack of skill as turners. This is not a satisfactory reason, however. The gouge and the skew chisel are not used as much as they might be, but for much pattern work scraping tools are undoubtedly the most satisfactory. There may not be general agreement on this point, but it will be approved by many men who have had a wide and varied practical experience.

In turning cylindrical work, the gouge could be used much more than it is. The T rest should be brought as close to the work as is possible, and when it has been roughed to a diameter, the rest should be again moved in. As to the correct height of the rest, if scraping tools are being used, it should be set so that the edge of the tool will be in contact with the centre of the work or very little above it, but, when the gouge is used, the rest should be above the centre of the work, an amount depending upon the diameter of the work being turned, in order that the angle of the gouge to the work will be less acute and the bearance on the rest as close to the end of the tool as possible. The gouge should be held so that its cutting edge is at a tangent to the revolving wood, and the cut applied by raising the back hand holding the handle of the tool. To finish off, the cutting chisel should be used, if the work is straight and not more than about 6 in. dia. It is, of course, also useful for shaped work, providing the shape varies gradually. The cutting chisel is the most difficult woodturning tool to use, and a few minutes' instruction from a practical hand will teach the apprentice more than much written directions. This tool is bevelled on both sides for use in cutting either to the right or to the left, whichever is desirable for the work being turned. This tool should be held at an angle to the wood, and in such a manner that it is at a tangent to it. It is necessary to hold it an an angle to free both corners of the tool and to give support on the rest directly opposite to that part of the tool which is cutting. Careless use of this tool is likely to end disastrously, because, if the point is allowed to catch the revolving work, it will tear it and probably pull it from between the centres.

The scraping tools that the patternmaker uses are square chisels, left- and right-hand skew chisels, round noses and diamond points, the latter being a double-skew tool with the cutting edges at less than right-angles to each other. As a rule, scraping tools are ground on one side only, and they should be ground at a less acute angle than is necessary for bench tools, because greater strength is needed. The writers are of the opinion that in all cases where a template is used the turning should be done with scraping tools, particularly faceplate work. Large cylindrical bodies turned between centres can be turned very satisfactorily by means of a small thumb plane. It can be set at an angle in the same manner as a cutting chisel, with the sole of the plane on the rest.

In nearly all pattern turning the whole job should be rough-turned before any part of it is finished. This eliminates vibration due to want of balance, and ensures greater accuracy. It should be remembered that it is safest to stop the lathe to adjust the rest and to use callipers.

The New Parliament.

Some Representatives of the Iron and Steel Trades.

From the number of members representing the industries of the country the new Parliament promises to be an exceptionally interesting one. In fact, it is necessary to go back as far as 1910 to find such a large number of candidates, either directly or indirectly, associated with the coal, iron, steel, engineering and allied industries. Although many have not been successful, the aggregate is still formidable, and we append brief details of the more prominent features of the careers of some of the new members to be elected :—

Barrow-in-Furness.—Mr. D. G. Somerville is head of the engineering and construction firm of D. G. Somerville and Company, Limited, of London, and is connected with a group of other engineering firms in this country and on the continent which carried out contracts for various Governments during and since the war. Mr. Somerville is a Scotsman, and served his time as an engineer.

Croydon—South.—Sir Allan M. Smith is chairman of the Engineering and National Employers' Federations and of the Employers' Section of the Joint Committee of the Industrial Conference. He was knighted in 1918.

Darlington.—The Rt. Hon. H. Pike Pease, who is a member of the well-known Pease family, is the second son of the late Mr. Arthur Pease, and was Assistant Postmaster-General in the late Government from 1915. He is a director of the Normanby Iron Works Company, Limited, Pease and Partners, Limited, Henry Stobart and Company, Limited, and the North Bitchham Coal Company, Limited.

Dudley.—Mr. C. E. Lloyd is very closely associated with the iron industry as chairman of N. Hingley & Sons, Limited, one of the few remaining marked bar houses. He is, of course, a member of the Birmingham Exchange and attends most Thursday markets. He is also a director of Lloyds British Testing Company, Limited.

Gorton.—Mr. J. Hodge (Lab.), originally a steel worker, is now president of the Iron and Steel Trades Confederation. He was Minister of Labour in 1917 and afterwards Minister of Pensions, 1917-1919.

Greenwich.—Mr. G H. Hume is a member of the Institution of Electrical Engineers.

Hammersmith—South.—The Rt. Hon. Sir William Bull, Bart., is chairman of J. W. Singer & Sons, Limited, iron and bronze founders, Frome, and a director of Siemens Bros. & Company, Limited, and Siemens Bros. Dynamo Works, Limited.

Hampstead.—Mr. George Balfour is an engineer, the founder and head of the firm of Balfour, Beatty & Company, Limited, and a director of several other undertakings, including the Scottish Power Company, Limited, Midland Counties Electric Supply Company, Limited, and the Lancashire Electric Light and Power Company, Limited.

Kingston-upon-Thames.—Mr. F. G. Penny was appointed some years ago general manager of the Eastern Smelting Company, Limited, and is now one of the London directors.

Middlesbrough—East.—Mr. John Wesley Brown is chairman of Hanson, Brown & Company, Limited, iron, steel, coal and ore merchants, of Queen's Square, Middlesbrough, with branches at Liverpool and Newcastle-on-Tyne. The company are agents for Bayliss, Jones & Bayliss, Limited, F. Dupre, Electro Metals, Limited, Eyre Smelting Company, Limited, and the Middlesbrough Fireclay Works.

Sheffield—Park.—Lieut.-Col. H. K. Stephenson is chairman of Thomas Turton & Sons, Limited, steel and file manufacturers, etc., Sheffield, and Stephenson, Blake & Company, Limited, typefounders. He has been Lord Mayor and Master Cutler of Sheffield.

Swansea—West.—The Rt. Hon. Sir Alfred Mond was First Commissioner of Works from 1916 to 1921. He then became Minister of Health on the resignation of that office by Dr. Addison. He was formerly associated with Brunner, Mond and Company, Limited, and the Mond Nickel Company.

The board of Henry Bessemer & Company, Limited, has been completely changed. Mr. A. G. Longden, Lieut.-Colonel Cecil Allen, and Mr. W. Wostenholme have retired, and a new board has been appointed. The new chairman and managing director is Sir Walter Preston, who is a director of J. Stone & Company, Limited, of Deptford. Mr. A. W. Rippon, of St. George Street, Westminster, who has been associated with Sir Walter Preston for some years, is to be the new commercial managing director, and will reside in Sheffield, and a third appointment to the board is Mr. R. Hargreaves, of Sheffield.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Hestia Core Stove.

To the Editor of The Foundry Trade Journal.

Sir,—With regard to "A Foreman Moulder's" inquiry in your last week's issue regarding the "Hestia" core stove, I can assure him that the makers have had ample experience in the drying of barrel cores, and that the results were very satisfactory. The design of the "Hestia" is such that it extracts all moisture without burning or scorching the face or foundation of the core, and thus leaves the core in the strongest possible condition.

As regards attention, the stove is charged with fuel about 5 p.m. and it is not touched from then until 8 a.m. the next morning. The fire can then be replenished or allowed to die out according to requirements. A steady temperature is maintained throughout the night.

Yours, etc.,
J. M. Lockhart.

46a, Market Street, Manchester.
November 20.

Manufacture of Locomotive Cylinders.

To the Editor of The Foundry Trade Journal.

Sir,—It is gratifying to learn that there are so many foundrymen anxious to know a little bit more of the method used at the G.E.R. Works, Stratford. In response to "Foundryman's" query about openness of structure, apparently due to the Si. being as high as 2.02 per cent., it is readily admitted that it is too high to conform to up-to-date practice, since Si. itself does determine the amount of graphitic carbon present and this controls the supposed openness of character of the iron. In conjunction with the other elements present, however, this property is to some extent modified, especially with the high sulphur content (0.125 per cent.) present. At the same time, in my opinion, the Si. is too high, as is also the P., but bearing in mind phosphorous hardens iron and that 0.125 sulphur is present, the conditions necessitate a higher Si. content than one would expect to use in the manufacture of castings of this class. With reference to the utilisation of a higher Mn. content, I again agree that with P. lower we could increase our Mn. to advantage, but under prevailing conditions I suggest that we do not want any more of the elements present which tend to harden the casting. It is admitted that Mn. softens iron to the extent with which it reacts with the S. Thus, summarising the effects of the different elements in the G.E.R. cylinder mixture, silicon is not too high in comparison with the amount of phosphorus, as the phosphorus content allowed before the limit of safety is reached is given as 0.7 per cent. Thus even here it is seen that we are working close to the danger line with the phosphorus. The evil effect of this element, that is the liquation, which takes place during cooling, is overcome by having the casting of uniform thicknesses. The sulphur content tends to close up the structures, whilst the Mn. 0.50 per cent. is quite sufficient to ensure soundness from blow-holes due to occluded gases. "Foundryman" suggested that the amount of charge (8 cwts.) was too small. If he refers to economy, I disagree, because this is determined by the fuel ratio, and in this case our proportion of coke to iron is 1 to 9. Bearing in mind that we use 50 per cent. of cold-blast and hematite pig-iron in the charges, and also that our iron is always brought down very hot, I claim this ratio to be satisfactory. Incidentally, if we charged 1 ton at a time, as suggested, this, I am sure, would raise the coke bed, which would introduce a tendency to "imperfect" combustion. The "Roots" blowers question is simply due to a typographical error, as we only use one at a time. The methods of moulding are not expensive, inasmuch that primarily our loam mixture is cheaper than our strong sand or "fat" mixture, and secondly the moulders are on piece-work, and find that less mending to the moulds is required when using our loam. The "sane inspection" of castings existing at the Stratford Works is merely due to the cordial co-operation of all concerned. It can truthfully be stated that the super-heater class of cylinders, under consideration, have not, up to now, as far as I know, had any blemish or faulty places.

Finally, sir, with reference to our mixture not being superficially satisfactory, may I submit an analysis of a mixture for hydraulic castings taken from McWilliam and Longmuir's text book on foundry practice, and for comparison repeat my own:—

	Si.	Mn.	S.	P.
McWilliam and Longmuir..	1.85	0.65	0.06	0.88
G. E. R. Cyl. Mixture ..	2.02	0.50	0.125	0.77

Yours, etc.,
A. F. Gibbs.

Gazette.

Castings (Congleton), Limited.—Mr. R. E. Clark, 17, Albion Street, Hanley, has been appointed receiver.

Sterling General Engineering & Motor Company, Limited, Westgate-on-Sea.—Mr. T. W. Ramsey has ceased to act as receiver.

Essex Engineering & Machinery Company, Limited, London, W.C.—Mr. F. J. B. Gardner ceased to act as receiver, November 3.

Mr. E. R. Vernon, trading as E. Vernon, jun., 16 and 18, Colmore Street, Birmingham, machinery dealer, has been adjudicated bankrupt.

Bradley Steel Strip Company, Limited.—It has been resolved:—That the company be wound up voluntarily. Mr. J. Gough, 267, Castle Street, Dudley, has been appointed liquidator.

Messrs. J. Fairbairn & Company, Kinningpark Brass Foundry, Vermont Street, Kinningpark, Glasgow, have dissolved partnership, by retirement of Mr. J. P. Fairbairn. Debts by Mr. R. Fairbairn, who continues the business.

Death.

Mr. J. B. Humphreys, director and manager of Ferguson Superheaters, Limited, 20, Kingsway, W.C.2, with whom he had been associated for many years, has died as the result of a motor-car accident.

Personal.

Mr. William Donald has resigned his directorship of the Eglinton Magnesite Brick Company, Limited.

The late Mr. J. Keeling, for more than forty years works manager to Charles Akvill & Company, iron-founders, West Bromwich, left £4,381.

Mr. C. W. D. Townsend, general manager of the Scunthorpe works of John Brown & Company, Limited, has been elected a local director of the company.

Dr. J. F. Crowley, on severing his connection with the English Electric Company, Limited, was the recipient of a presentation from his friends and colleagues.

Mr. James Dickinson has been appointed as a lecturer in Electrical Engineering at the Armstrong College, Newcastle, in place of Mr. J. A. Harle, who has received an appointment with a Tyneside firm.

Dr. G. B. Waterhouse, an ex-Sheffield University metallurgical student, has been appointed Professor of Metallurgy at Massachusetts Institute of Technology. Since 1908 he has been technical director of the Lackawanna Steel Company, Buffalo, U.S.A.

Mr. Francis William Gilbertson, J.P., of the Mumbles, and Sir Aubrey Brocklebank, of Sandiway, Cheshire, have been elected as directors of the G.W.R. Company to fill vacancies caused by the resignations of Sir John T. D. Llewelyn and Mr. Ernest H. Cunard. Mr. F. W. Gilbertson is a member of the council of the Federation of British Industries, and a director of the Slag Phosphate Company, Limited, and of W. Gilbertson & Company, Limited.

Trade Talk.

Henry Brice and Company, engineers, have removed from Thornton Heath to 37, Jewry Street, London, E.C.3.

The British L.M. Ericsson Manufacturing Company now have their offices at International Buildings, 67/73, Kingsway, London, W.C.2.

Cook & Nicholson, Limited, and the Fredk. Crane Chemical Company, Limited, have been elected members of the Federation of British Industries.

I. Hood & Company, Limited, 7, St. Stephen's Avenue, Bristol, have been appointed agents in the West of England for Brook, Hirst & Company, Limited, Northgate Works, Chester.

The Cleveland Bridge & Engineering Company, Limited, have secured the contract for the steelwork for the widening of the Great Northern Railway from Fletton Junction to Peterborough.

The Sheffield File Trade Technical Society discussed file testing on November 9, when a paper was read by Mr. H. G. Smith in the Mappin Hall of the Applied Science Department. Mr. J. L. Howard presided.

A meeting of the Scottish Centre of the Institution of Electrical Engineers was held last week in Glasgow. Mr. A. S. Hampton, president, delivered his inaugural address, which dealt with the economic aspect of railway electrification.

G. & J. Weir, Limited, Cathcart, Glasgow, have made arrangements with Messrs. Sulzer Frères, Winterthur, to build the new type of Diesel engine recently developed by the Swiss firm, and to apply it to marine auxiliary purposes.

Donovan & Company, electrical manufacturers and suppliers, 47, Cornwall Street, Birmingham, have appointed Mr. David Alexander, of 43, Mains Street, Waterloo Street, Glasgow, as their agent in Scotland for Ironclad switch and fuse gear.

At a meeting of the Glasgow and West of Scotland Foremen Engineers and Draughtsmen's Society, held on November 11, Mr. Thomas Taylor presiding Professor A. L. Mellanby delivered a lecture on "Some Steam Turbine Problems."

A destructive fire broke out on November 11 in the works of Reid, Macfarlane & Company, Limited, Maxwell Road, Shieldhall, Govan. The outbreak originated in the store at the east end of the main shop, and considerable damage was done.

A fusion has been effected between the firms of T. Cooke & Sons, Limited, of London, York, and Cape Town, and Troughton & Simms, Limited, of London and Charlton, and in future business will be conducted under the name of Cooke, Troughton & Simms, Limited.

Mr. D. S. Paxton, district representative for Brown, Boveri & Company, Limited, Power-Rectifiers, Limited, the Visco Engineering Company, Limited, Electromobile, Limited, Snow & Company, Limited, has removed to Campfield Chambers, 312, Deansgate, Manchester.

Mr. A. J. G. Smout, the president of the Birmingham Metallurgical Society, recently visited the Wolverhampton branch at a meeting held in the Technical School, and delivered the opening lecture, of the session on the subject of "Fuel Economy in the Metal Industry."

A meeting of the Birmingham Metallurgical Society was held at the Chamber of Commerce on November 9, when Professor R. P. Haigh, of Greenwich Naval College, delivered a lecture on the elastic and fatigue limits in metals. The president of the society, Mr. A. J. G. Smout, was in the chair.

Three vessels of 14,900 total net tons were launched on the Tyne in October, compared with seven vessels and 28,923 tons in the corresponding month of last year. From January 1 to October 31 there were launched 32 vessels of 119,189 tons, as compared with 55 vessels and 171,061 tons in the corresponding period of last year.

The Tyne Commission has accepted the tender of Palmers Shipbuilding & Iron Company, Limited, for the construction of four single-screw steel hopper barges, each of 800 tons capacity, subject to the hulls of the vessels being built on the Tyne. The agreed price is £76,000, the first craft to be delivered in six months' time.

The monthly ascertainment shows that the average selling price of West Coast Bessemer mixed numbers during October, 1922, was £4 10s. 4d. per ton, an advance of 11d. on the previous month, and the wages of blastfurnacemen in Cumberland and North Lancashire are accordingly increased by ½ per cent. to 30½ per cent. above the standard.

Meldrums, Limited, Timperley, near Manchester, have, during the last two months, taken 13 orders for forced draught furnaces and mechanical stokers, including chemical works, gasworks, engineering works, and collieries (one a repeat for 18 boilers to be fitted making 23 in all this year). Orders for destructor furnaces number six, including chemical works and two railways.

A meeting of the Joint Board in connection with the South Wales steel industry was held at Swansea on November 10, for the purpose of considering an application from the men for the renewal of the *ex gratia* bonus for another three months and the consideration of other claims. Mr. F. W. Gilbertson presided. The employers agreed to extend the *ex gratia* bonus for another three months, but in regard to applications for an increase in the base rates of the lower-paid men and the abolition of the putting of gas into furnaces in certain works on Sundays, they expressed regret at inability to accede.

At the last meeting of the Diesel Engine Users' Association Mr. G. E. Windeler read a paper on the "Care and Maintenance of Diesel Engines," in the course of which he referred to the action which had been taken by the Association in collecting information with regard to Diesel engine working costs. Apart from the advantage which members were likely to gain individually from the collection of such data annually, it seemed to him only proper that the Association should at the earliest possible moment put itself into the position of being able to supply definite average figures of working costs based upon actual results obtained in the operation of representative Diesel engine installations.

Jordans, Limited, and Thomas Spittle, Limited, have decided to accept the offer of the Newport Corporation with respect to the Talybont pipe line contracts. These firms withdrew their tenders to supply pipe lines owing to conditions imposed by the Corporation. In view of the large amount of unemployment in the town, there was a strong feeling that the contracts, amounting to £101,960, should be let to local firms, and the Corporation decided to ask Messrs. Spittle and Messrs. Jordans whether they would agree to accept the contract on the same terms as it had been provisionally let to Cochrane & Company, Limited, Middlesbrough. We understand that the Newport firms mentioned have now agreed to do so.

The National Committee of the Amalgamated Engineering Union have circulated in their branches a manifesto setting out the total expenditure from July, 1920 (when the eight engineering unions were amalgamated), until June of this year. The total amount paid out, according to the rules, during the period under review was £4,056,458. Of this amount £2,672,306 went in unemployment benefit, and £800,000 in sickness and superannuation. In addition £577,256 was paid out as the result of special levies. The total cost of administration amounted to £522,307, equal to 2s. 6½d. in the £. Members are urged to realise the seriousness of the position, and are informed that it is wholly due to the heavy drain on the funds because of unemployment that certain benefits have since been stopped.

A Substitute for Small Forgings.—In a recent issue of "The Iron Age" Mr. Larry J. Barton describes the manufacture in an electric furnace of alloy steel castings to be heat-treated and used as a substitute for forgings, and for purposes where the ordinary grades of steel castings are unsuitable. The author remarks that there are many cases in mining and other work where a superior product is desired, and quite often the shape is such as to make forging very difficult, if not impossible. For this work it has been found that a properly made and properly heat-treated alloy-steel casting furnishes a suitable material. Not only can certain conditions be met, but by changing the treatment the same metal can be used for several different purposes. This results in being able to send out several castings, all of the same chemical composition which, when treated according to the directions sent with them, will cover widely differing specifications. Steels containing chromium, nickel and vanadium offered the most feasible and versatile products for the different classes of work covered. Some castings contain only nickel, some only chromium, some varying combinations of nickel and chromium, and some consist of different amounts of all three elements. Carbon content is adjusted to meet the varying conditions. The author recognises the difficulties in obtaining a uniform product, and remarks that often castings poured from the same heat and treated in the same manner will show widely differing results, and explains this by a difference in structure caused by different pouring temperatures, different texture and temperature of the mould, etc.

IRON AND STEEL MARKETS.

Pig-iron.

Conditions in the pig-iron industry remain much the same as reported during the past few weeks, and although it is now too late to hope for any important developments during the concluding period of the year, it is confidently assumed in trade circles that the change of Government resulting from the election just finished will ensure something nearer stability than has been experienced over the last four years. In the Midlands, prices of pig iron continue remarkably firm, while reports indicate that demand for ordinary forge quality is maintained, and that some of the heavy foundries are rather better customers than they were earlier in the year. This improvement, however, is relatively slight, and the furnaces already in blast are able to cope with it quite satisfactorily. There is not sufficient volume of demand to tempt owners to blow in additional furnaces, nor is there anything in the price obtainable to induce them to do so. The Scottish pig-iron market is reported slightly easier, with a tendency on the part of makers to shade prices with a view to attracting buyers. With the falling away of the American demand there is no compensating inquiry or orders coming from other directions, and probably some of the works are now stocking iron in their yards. If these conditions continue, it is not unlikely that we may see the blowing-out of furnaces, and as there are only 29 on foundry, and three on hematite in operation in Scotland, the suggestion that the production will require to be diminished, shows that the iron and steel trade of the district is still in a very poor state. At Sheffield buying shows a more active tendency, the qualities most favoured being basic and foundry, while the demand for hematite implies some improvement in steel-trade conditions. The Cleveland iron market remains quiet as concerns home demands, while further weakening in the Continental exchanges is by no means favourable to the prospects of the export trade of Tees-side. Confirmation of this fact is found in the shipments return for Tees-side so far this month, showing that up till and including the 14th inst. the total is only 21,809 tons, as compared with 31,503 tons in the corresponding period of last month. The decrease is, of course, explained by the falling-off in the Transatlantic trade for the time being, but it by no means follows that buying on American account has finally ceased. It must still be remembered that Cleveland iron is several dollars below American prices, and while this state of affairs obtains business will continue. But buyers are cautious, and inquiries to hand during the last few days appear to be for prompt cargoes. For foundry iron to special analysis there is, however, still quite a brisk demand, and contracts are being made for delivery over the first quarter of next year at about 97s. 6d. per ton. The following are current quotations, f.o.b. and f.o.t.:—No. 1 and silicious, 97s. 6d.: No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s., while mottled and white, which are nominally 82s. 6d., could probably be done at from 80s. to 81s. 6d. per ton.

Hematite is certainly the strongest feature in the pig-iron market at the present time. Demand is well maintained, and several makers are fully sold till the end of the year. The inquiry from America also continues, and new business is reported during the past week, including substantial quantities for delivery early in the new year. Quotations are firmly held, 93s. being a minimum figure for East Coast mixed numbers, with the No. 1 quality at a premium of 6d. to 1s. per ton. West Cumberland and North Lancashire qualities of hematite are also a strong market, buying being heavier, not only on export, but also on home account, and users are extending their commitments well into January. In short, a greater stride forward has been taken of late than it has been possible to record for eighteen months past. A natural result of course is the relighting of additional furnaces. The ordinary iron is going to America and to the Continent in 1,000-ton lots, and to Scotland and South Wales. Prices are firm, Bessemer mixed numbers being quoted at £5 10s. per ton delivered at Glasgow and Sheffield. Consumers in the Midlands are taking the greater part of the make of low phosphorus iron, and prices vary according to analysis.

Finished Iron.

Business in most sections of the finished iron industry continues in a languid condition, only a small percentage of works providing regular employment, chiefly confined to manufacturers with fairly substantial contracts in course of execution. A general complaint in the trade at present is an abnormal hesitation on the part of consumers in placing forward business, most buyers confining transactions to more immediate requirements, which, at the moment, comprise orders on almost a retail scale, giving only temporary relief from total unemployment. Notwithstanding these somewhat gloomy conditions there is now in evidence a much more hopeful feeling that the worst is passed, and manufacturers look forward to the coming year to redress the stagnation so long prevailing in the trade. In South Staffordshire makers of the commoner qualities of bar iron are feeling the full intensity of Belgian competition. For instance, Belgian No. 3 bars have been offered at £7 10s. delivered Birmingham. The quotation for the corresponding quality made in the district is £9 15s., and it may seem an extraordinary anomaly that this price has been obtained notwithstanding the tremendous advantage which, on the surface, appears to rest with the foreigner. The Midland quotation is, however, fairly firm, but if sellers are urgently in want of orders, or if specifications are particularly attractive, concessions are obtainable. There is still only a quiet trade in crown and marked bars, and no doubt it will remain so until such time as the cost of production is lowered and makers are able to sell profitably at a price more in keeping with the prevailing general commercial conditions. The iron-strip trade shows no improvement.

Scrap.

Reports from most of the scrap metal markets indicate awakening activity of demand for certain qualities of material, but, on the whole, the general position of the trade leaves much to be desired in the scanty volume of business open at the moment. In the Midlands the improved demand for heavy steel scrap recently reported has been maintained, and prices are considerably firmer. The same remark also applies to heavy steel turnings, although, in this instance the price is not quite so firm, and supplies are very difficult to obtain. Heavy wrought-iron scrap is in good demand, but prices, up to the moment, have not shown any signs of improving. The demand for cast-iron scrap is relatively small, and prices offered, taking into consideration the intrinsic value of the material, are low. On Tees-side the scrap market just now is rather quiet, and except for heavy steel scrap there is no considerable volume of business passing. For heavy steel there is still a good demand, with the price held round about 68s. per ton, delivered works. Other quotations, all delivered works, are as follows: Heavy steel turnings, 54s.; cast-iron borings, 52s. 6d.; heavy cast-iron machinery scrap in handy pieces, 75s. to 77s. 6d.; heavy wrought-iron bushelling scrap, 55s. to 57s. 6d.; ordinary heavy piling, 60s.; specially selected heavy forge, 70s. to 75s. per ton.

Steel.

Gradual improvement is again noticeable in various branches of the steel trade, and although progress is necessarily slow, the prospect of further development is apparently assured early in the new year. At Sheffield buying movements in series are increasing satisfactorily, orders coming forward for basic billets with comparative freedom, both on home and export account. There are also inquiries for acid qualities of billets, though only in a small way at present, and an improvement is noted in alloy steels. Railway and motor steels are decidedly better. Within the past week or so further steel furnaces have been put in operation. A good deal of price-cutting is reported, and some of the business is taken at figures which cannot possibly yield a profit. But work keeps men together and plant active, and this is reckoned as something of an asset. The spring branch is a striking example of the cutting of prices that is going on, and the fact that some springs are being sold at less than the Association's figures is regarded as a menace to that organisation's future. Several classes of wire rods have been reduced in price. The business in ferro-managnese continues fair on both home and export account, although, of course, American orders have fallen off. Values are unchanged. The tinplate market has taken a somewhat quieter turn, but most of the works are well booked till the close of the year. At the Exchange meetings last week makers and merchants discussed a further decision by the Welsh tinplate makers, arrived at recently, to advance the minimum price of tinplates by another 3d. per basis box, bringing the minimum up to 19s. 6d. f.o.b. Bristol Channel ports. Merchants are protesting against the makers fixing the selling price without making a percentage allowance to them.

Metals.

Copper.—The market for standard copper may again be reported as consistently firm, values covering a very narrow range in quotations, with fluctuations only varying a few shillings during the past week. Consumption at home, though far from the normal

quantity, is on steady lines, and the demand is fairly well maintained. France also has latterly taken larger quantities, while, in spite of the conditions of the exchange, Germany has re-entered the market, although not to any great extent. Encouraging reports come from America, and the feeling prevailing over there with regard to the future of the market appears to be optimistic. The position, however, in the United States seems a little uncertain, although stocks are certainly being cleared away, but the prospect of increased output is a restraining factor. Copper at its present level of values is still a comparatively cheap metal, but consumption must materially increase before prices are more permanently advanced. Current quotations :—*Cash*: Wednesday, £63 7s. 6d.; Thursday, £63 5s.; Friday, £63 7s. 6d.; Monday, £63 5s.; Tuesday, £62 17s. 6d. *Three Months*: Wednesday, £64 5s.; Thursday, £64 2s. 6d.; Friday, £64 5s.; Monday, £64 2s. 6d.; Tuesday, £63 15s.

Tin.—Market conditions with regard to this metal continue active, with rather more buying on the part of consumers, while America is also taking more interest of late. Sales are reported in the East amounting to a good tonnage. Advices from Hong Kong indicate that the position there is unchanged; stocks are low and producers, in spite of the fall in silver and the consequent depreciation of the Hong Kong dollar, refuse to sell. It is stated that the Federated Malay States Government has withdrawn its stock of about 10,000 tons of tin from the Straits Trading Company, and placed it in Government warehouses. The object of this move is not clear. Possibly the Government only wish to reduce warehousing expenses, but, on the other hand, it may be their intention to liquidate with the smallest possible degree of publicity. Current quotations :—*Cash*: Wednesday, £182 5s.; Thursday, £178 10s.; Friday, £177 10s.; Monday, £178 7s. 6d.; Tuesday, £178. *Three Months*: Wednesday, £182 17s. 6d.; Thursday, £179 5s.; Friday, £178 2s. 6d.; Monday, £179 2s. 6d.; Tuesday, £178 15s.

Spelter.—The market for this metal maintains its strength, scarcity of supplies and substantial "bear" operations infusing considerable animation in the business transacted of late. The high prices have induced sales of American spelter for export to this country, state Rudolf Wolff & Company, but owing to consumption in America having been for some months in excess of supply, the surplus for export can only be on a limited scale. On the Continent the position is strong, there being no appreciable tonnage available for export. Current quotations :—*Ordinary*: Wednesday, £39; Thursday, £39 2s. 6d.; Friday, £39 5s.; Monday, £38 7s. 6d.; Tuesday, £37 15s.

Lead.—Quieter conditions have been in evidence of late in the market for soft foreign pig, chiefly affecting forward business. The tendency of the market is firm, and with trade slowly improving it seems more probable that an advance in prices will take place. These conditions, however, must be ascribed more to a certain reticence on the part of sellers than to any particular expansion in the demand. Current quotations :—*Soft foreign (prompt)*: Wednesday, £26 10s.; Thursday, £26 5s.; Friday, £26 2s. 6d.; Monday, £26 2s. 6d.; Tuesday, £26 10s.

Contract Open.

Toronto, Canada, November 28.—The Department of Works of the City of Toronto invites tenders for the supply of 242 lengths of 20-in. cast-iron pipe for high-pressure fire service mains; 12 ft. long exclusive of the hub, with thickness of metal about 1½ in. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Room 47.)

Foundry Query.

A Steel-making Alloy.

I shall be pleased if any of your readers can give me the name of any firm handling Dartrian or Dartum metal.—"PHYSIC."

Company News.

Milford Haven Electric Welding Company, Limited, 129, Bute Street, Cardiff. Capital £2,000. Permanent managing director: D. W. Thomas.

Roberts Bros. (Engineers), Limited, Bradford.—Capital £1,500.

Robson Refractories, Limited, 1, North Road, Darlington, Durham.—Capital £15,000 in £1 shares (5,000 preference and 10,000 ordinary). Directors: E. C. Robson and W. Thiemann. Secretary, N. F. R. Dinsdale.

R. S. Thacker & Company, Limited, Granville House, Arundel Street, Strand, London, W.C.2.—Capital £1,000 in £1 shares. Engineers. Directors: R. S. Thacker and Capt. B. I. Winnall.

Switches, Limited, 281-3, Gray's Inn Road, London, W.C.1.—Capital £1,000 in £1 shares. General engineers. Directors: S. W. Wilkins, H. H. Supper and A. G. Joiner.

The Barrowfield Iron Works, Limited, 100, Fordneuk Street, Bridgeton, Glasgow.—Capital £30,000 in £1 shares, to acquire and carry on the undertaking of the Barrowfield Iron Works, Limited, in voluntary liquidation.

Ultimax Manufacturing Company, Limited, 70-80, Cornish Street, Sheffield.—Capital £1,000 in £1 shares. Engineers, etc. Directors: A. C. J. Charlier (chairman), E. R. Wikeley, A. E. Coyne and F. A. Charlier.

Brown, Bayley's Steel Works, Limited.—Loss, £66,883; brought forward, £20,040; debit balance on revenue account, £46,843.

Weardale Lead Company, Limited.—Profit, £12,296; deficit in accounts for 1921, £3,286; set aside for corporation tax, £250; credit balance, £8,759; dividend, 6 per cent., £5,875; carry forward, £2,884.

Brett's Stamping Company, Limited. — Loss, £3,523; brought forward, £5,229; transferred from general reserve, £5,000; available, £6,706; dividend, 5 per cent. on ordinary, less tax; carry forward, £4,412.

Birmingham Aluminium Casting (1903) Company, Limited.—Profit, £5,791; brought forward, £27,966; dividend, 7 per cent. cumulative preference shares; ordinary dividend, 5 per cent., free of tax; carry forward, £23,757.

W. H. Dorman & Company, Limited.—Net surplus, £10, after providing for interest on 8 per cent. participating seven-year notes and taking credit for £28,676 taxes recovered. Board state that £30,000 required for working capital, and propose to create £150,000 10 per cent. second debentures, of which £80,000 will be offered to shareholders.

A New American Foundry Technical Association.

A new society has been formed at Quad City, Rock Island, Illinois. The second meeting was held on October 16, with an attendance of 90, when Dr. Richard Moldenke, Watchung, N.J., gave an address on general foundry practice. The association had a representative attendance from 27 gray iron, malleable, steel, brass and aluminium foundries. A. E. Hageboeck is president; John Ploehn, vice-president; and R. L. Van Alstyne, secretary and treasurer of the association.

MR. B. D. FRANK DOCKER, managing director of Docker Bros., Limited, and a director of the Metropolitan Carriage, Wagon and Finance Corporation, Limited, has been elected a director of the Anglo-Argentine Tramways Company.

CUMBERLAND iron ore miners wages are now as follows (per day or shift): Underground workers.—Miners working bargains, 9s. 2d.; miners minimum, 6s. 6d.; first-class or leading labourers, 5s. 11½d. Surface workers.—Winding enginemen, 8s. 1¼d.; joiners, 8s. 8½d., plus 6d. tools allowance; chargemen and mineral shot borers, 8s. 8½d., plus 3d. per foot; blacksmiths, 8s. 8½d.; other grades are increased by amounts varying from one farthing to one penny per shift.

THERMAX Core and Mould OVENS Excel all other Designs — The Manchester Furnace, Ltd. — Ashton New Road — Manchester

THE

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Contents.

	PAGE
Belgian Foundry Costing	435
The British Cast-Iron Research Association	436 and 440
An Electric Duplexing Process	436
Catalogues Received	436
Jobbing Foundry Moulding Boxes, with Some Notes on Runners and Risers	437
An Apprenticeship Course in Foundry Practice—XX.	441
Nitrogen in Iron and Steel	443
Institution of British Foundrymen	444
Book Review	450
Smoke Abatement	450
Rubber Equipment in the Foundry	451
Trade with Japan	452
The New Parliament	453
Trade Talk	453
Iron and Steel Markets	454
Gazette	456
Company News	456
Deaths	456

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

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Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Belgian Foundry Costing.

The Belgian Foundrymen's Association recently appointed a committee to report upon the procedure to be followed to ascertain the cost price of grey-iron castings. The conclusions arrived at were published in the October "Bulletin" of the Association, Mons. G. Masson, foundry manager to Messrs. Ketin, of Selessin, being the secretary. Their work was divided into four main sections:—(*a*) Ascertaining the price of the liquid iron ready for the mould. (*b*) Wages. (*c*) Other costs. (*d*) General remarks. Section (*c*) admitted of four divisions:—(1) Manufacturing costs; (2) stores; (3) overhead charges; and (4) selling prices

The first section is of great interest for British foundrymen as cupola costs can mean the obtaining or losing of an order or the difference between a profit and a loss. For the ascertaining of this figure the foundry is required to send in after each blow a charge sheet setting out the quantity and quality of all materials used, the rough weight of the castings made and to what order number, and the weight of the over-metal. On the reverse side the exact weights of the cleaned castings are given. After reducing the pig-iron charges to money values, transport, unloading and pig- and scrap-breaking charges are added, after which all the other materials used during the month not only those necessary for melting but also costs of upkeep and repairs of the cupolas, blowers, hoists and ladles. *The sum thus expended is divided between the various mixtures in the ratio of the production.* Wages and power are apportioned in the same ratio. The former is made to include cupola staff, labourers (masons) detailed to prepare the ladle, and a portion of the mechanics' time when engaged on this plant. There is further to be added that proportion of the laboratory costs appertaining to the analysis of raw materials, and a portion of the yard costs, divisible between melting, moulding and dispatching, to be based on either tonnage or numbers of wagons. Finally, there is the depreciation, which the Committee recommend to be 5 per cent. for cupolas, blowers and hoists, and 10 per cent. for large ladles and 100 per cent. for shanks and accessory material. The annual amount to write off will not be by months or twelfths, but on production. If a plant should produce 1,500 tons per annum, has cost x pounds, and allowing the 10 per cent. depreciation, then the amortisation per ton will be x divided by 10, multiplied by 1,500. This means that if standard production has not been attained then the depreciation will be extended.

After adding all the above factors, runners, risers and over-metal are substracted at scrap value. If this figure, when converted into price per 100 lbs. for any one mixture, is called y, and if it takes 100 lbs. of metal to make 85 lbs. of castings, the cost price of the iron for that grade of casting is y multiplied by 100 divided by 85. The difference between this figure and the cost of the iron mixture per unit weight represents the "transformation cost," which can be utilised as a rough basis for quoting so far as the iron is concerned. Under Section (2)—wages—the committee make nine divisions—(1) pattern-making; (2), loam moulding; (3), core-making: (4), hand moulding (*a*) dry, (*b*) green; (5) machine moulding (*a*) dry, (*b*) green; (6) unloading raw materials; (7) cupolas; (8) fettling; (9) dispatching.

The system outlined is a card system, whereon the workman puts the number of hours expended on each job. Whilst the balance of the report has not such a direct concern for the foundryman and presents little novelty, it is interesting to note that the hundred and one small stores, such as blackings, chains, sprigs and the like, which cannot be charged to any one job, are made a general overhead charge.

The system of basing metal costs on each mixture used in the foundry appears to be excellent for machine-moulded castings, but it obviously assumes less importance when loam-moulding very heavy castings, as in such cases the major portion of the cost falls on the moulding side, and the metal costs are comparatively insignificant. The Belgian Association is to be commended on its work, and it is well worth the while of other countries to follow, especially if it helped to suppress the system of a standard weight-price for every order received for one firm.

The British Cast Iron Research Association.

Progress of Research Work in Hand.

In the monthly circular for November the new Director of Research (Dr. P. Longmuir) states that since commencing his work he has been taking stock of the position of the principal researches in hand and formulating a scheme for their progressing as rapidly as possible.

Cast Iron Moulds for Making Glass Bottles.—The Director has arranged a scheme of research upon moulds for these, special castings will be made at once for the purpose of practical works tests. There is a very wide field here to give the members a new trade opening. A large number of these moulds are imported from abroad. These will, it is hoped, be now made in this country.

Magnetic Properties of Cast Iron.—Enquiries having been sent in to the Association upon this important matter, the Director is taking steps to commence an investigation so that the Association can be in a position to advise members upon same.

High Silicon Cast Iron to Withstand Mineral Acids.—It has been pointed out to the Association that a research into this material is of very great importance to the cast-iron industry and to other allied trades. Some work has already been done by outside agencies without very great results being obtained. The Association will, therefore, take the matter up at once.

Standardisation of Testing Methods for Cast Iron.—The Special Committee appointed to investigate the standardisation of test bars are collecting a large amount of practical data and have received valuable help from the American Testing Society. A questionnaire has been issued and the replies are being tabulated; the conclusions of the Committee will be of great assistance in drawing up an international standard for testing.

Suggestions from Members.—The Director will welcome suggestions from members as to possible new lines of research that will benefit the industry generally, and will be glad to interview members upon any suggestions that are made.

Problems Received.

During the past month the problems sent in by members for investigation have been of a varied nature, and again prove the value of the Association in being able to remove difficulties which must tend to retard production. Reports upon the following problems have been sent to members, copies of which will be published in the Bulletin:—

Mixture for chilled cast-iron brake blocks; Chromium in cast-iron casting; Mixture for cast-iron desilverising pots; Cupola fans and blowers; Cupola practice for heavy castings; Mixture for heavy castings; Cupola proportions for special work; Testing Diesel-engine cylinders; Chilling iron rolls; Mixture for cast-iron balls for grinding mills; Cupola melting practice; Defects in valve castings; Mixture for special malleable castings; Cupola design for special melting.

The Bureau and Library.

The "Intelligence Service" of the Bureau has been called upon during the past month to supply data and copies of papers upon a variety of foundry subjects. Associate members particularly are using the Bureau to assist them in their work. The Bureau has not yet failed to supply any data or information asked for. Whenever it is used its great value is at once brought home to the member.

Membership.

During the past month several new members were elected, and an exceptional large number of applications have been received from foundries for details of membership, showing that as trade revives they are recognising that it is to their interest to join the Association, and so enable it to carry out the larger research works for the improvement of the methods of manufacture which the industry has so long waited for. The Council desire to double the membership during the present financial year, and every foundry should help to attain this end.

Annual Report.

The Council have issued their Report of the first year's work, a copy of which will be forwarded to anyone interested upon application.

Members' Crest.

It is very important that purchasers of iron castings should know who are members of the Association, as such membership gives them a guarantee that the Association's advice can be obtained for the better production of their work. It has therefore been decided that members can use the Association's crest upon all their stationery. The various Government Purchase and Contract Departments have been advised as to the significance of the crest.

An Electric Duplexing Process.

An interesting new steel-making process has been put into successful operation at the works of Messrs. Edgar Allen & Company, Limited, Sheffield, which promises a great revolution in electric steel melting in the near future.

The Stobie Steel Company of Dunston-on-Tyne, has installed in those works one 10-ton and one 3½-ton electric steel-melting furnaces which are being worked together as a single unit under the Stobie patent duplex electric process. By this means, scrap steel is electrically melted and refined by oxidation in a continuous manner in the large primary furnace, and a third or more of the molten bath is transferred down a shoot at short intervals to the small secondary furnace for finishing.

Electrical and Metallurgical Advantages Shown.

Electrically, the load factor is greatly increased by the continuous working, and the power factor is much improved by the maintenance of, mainly, molten baths. Fluctuations of current are, also, less marked and of shorter duration.

Metallurgically, the main advantage is the frequent supplies of small quantities of steel, of varying compositions if required, at the low cost of operating plant of large output. For ingot or foundry work, this advance in practice is of considerable interest. Such a process should go far to the commercialisation of the centrifugal casting of steel, as it should provide a more continuous source of liquid steel.

Additional advantages of the new process over an installation of several furnaces working independently include the less space occupied by the plant; the reduced crane service required; the much reduced repairs to furnace linings for a given output of steel, and the freer choice in scrap for melting.

Catalogues Received.

MESSRS. LAWSON, WALTON & COMPANY, LIMITED, 2, St. Nicholas Buildings, Newcastle-on-Tyne. Foundry supply stock list for November.

MESSRS. CONSETT IRON COMPANY, LIMITED, Consett, Durham. Booklet containing representative photographs of the various grades of pig-iron they manufacture.

THE SKEFCO BALL-BEARING COMPANY, LIMITED, Luton. A catalogue giving much useful information about ball-bearings. A section is devoted to their lubrication.

MESSRS. UTILITY PRODUCTS, LIMITED, 212, Hunter Street, Glasgow. A catalogue for Ford car users, outlining the utility of Hudco-Ford pedal slip transmission covers, which reduces the time of removing brake band linings to twenty minutes.

A General Council meeting of the Institution of British Foundrymen is to be held at York on December 9.

AMERICAN FOUNDRY PRACTICE.—"My Visit to American Foundries and Impressions" is the title of a lecture which Mr. Oliver Stubbs, M.I.Mech.E., past-president of the Institution of British Foundrymen, will deliver before the Lancashire Branch on December 2.

Jobbing Foundry Moulding Boxes, with Some Notes on Runners and Risers.*

By C. Bickerton, A.M.I.Brit.F.

This Paper deals only with the heavier type of moulding boxes, which are usually lifted by mechanical power. A moulding box, as seen on its side, apparently presents little difficulty of manufacture, but deeper consideration shows that its usefulness and durability depend upon its construction. It is quite common to find boxes over 5-ft. sq. broken at the corners, due to contraction. These are usually clamped or burned, or provided with a wrought-iron patch.

The largest box made by the Author weighed 8 tons. It was 16 ft. long by 11 ft. wide by 12 in. deep. Of the timber used the outside frame was 2 in. wide, the inside bars being 1¼ in. These figures refer to the rough state, which necessitated planing in order to give it the necessary taper. Though made about 10 years ago, it is still in good condition. During this period it has been used for heavy work with deep lifts, and at other times for moulds involving numerous heavy cores, the box having to be turned over with these in position.

The range of boxes made by the author varied from 16 ft. × 10 ft. 6 in. × 12 in. deep to 4 ft. square by 6 in. deep. The method utilised for avoiding contraction breaks was by putting lugs on the corners, and casting-in splitting plates provided with bolt holes. After casting, the inside bars are covered over with sand, leaving the outside portion uncovered, as this latter is thicker. The various lugs that are cast-on are for splitting, staking and handles. It is preferable to leave the box in the sand until cool. When the casting is fettled, bolts are put in the corners, and if the splitting plates have become loose, packing is used to replace them, the whole job being screwed up, but not too tightly. All boxes greater than 4 ft. 6 in. sq. should be split at the corners, and should have holes cast in the ends for bolting on extension pieces. Another precaution which is advisable when making balance weights or similar castings having a thick body of metal, is to keep the bars at least 2 in. from the casting, and if convenient, to take the top part off as soon as it is thought the casting has set, otherwise the box may be found to be broken the following morning.

Of the timber used for this type of box, the outside frame should be one and a-half to twice the thickness of the inside bars. Boxes greater than 2 ft. 6 in. sq. are often found to be useful when a central square space is left to admit the long bosses associated with wheels, pulleys, and the like, for it saves a deep lift, as it is possible to bolt a small box-part on the top. Holes should be cast in the two sides of this space, and loose bars cast to bolt in when used for a flat top. Two important factors which need emphasis are the necessity for employing good metal, casting at high temperature, and the use of strong lifting handles. Obviously weak handles are dangerous, and if broken off, the box becomes much more difficult to handle. On one occasion when turning over a box one of the handles gave way on reaching the vertical position, necessitating the use of props, whilst two bars were cut out in order to thread a chain through it to lower it down. This box was 13 ft. × 8 ft. × 10 in.

Weighing Machine Girder Box.

An interesting box which was made by the author was one for making a weighing machine girder about 21 ft. long. It was a Government order, and a joint mark in the middle of the casting was objected to. This necessitated the use of one box for the whole job. A box 22 ft. long and 3 ft. 8 in. wide takes up much storage room, and is not likely to be used often. It was therefore made in two lengths, and was bolted together in the middle. The order being completed, the box was dismantled, and when placed on end took up very little shop room. Square holes were cast in the ends of each half for swivels, so that they could be turned over on trestles.

On assuming a fresh position, the author found half-completed a box for a dry-sand job to be cast on end. The pattern was cylindrical and of different diameters. It incorporated a large flange about 1 ft. from one end. The outside frame was already cast and bolted together, with holes for loose bars to be bolted in. There were 17 bars for each half to suit the different diameters of pattern. The dimensions of each half-frame were 7 ft. 7 in. × 2 ft. 3 in. × 1 ft. 4 in. There were four bolt holes for each bar. Instead of making all these bars an ordinary box pattern was made, 6 in. deep, to drop inside the frame with the core prints in position to suit the holes cast in the frame. Two of these were cast without handles and bolted into the frame, using for this purpose 12 bolts for each half, instead of 17 bars with four bolts in each bar. This box can now be used for patterns of various diameters without alteration.

Troubles from Pins.

The pins for this box presented difficulty. Holes were cast in the lugs, in one part being about ⅞ in. sq. and in the other 1¼ in. × ⅞ in. This made it almost impossible to make a good joint. However, the joint in the box was marked before parting, and on closing the marks met correctly, and it was bolted and cottered up. When the mould was stripped it was found that the casting was twisted, probably due to putting the mould on end for casting, which might have allowed the pins to move. To prevent a recurrence of this the slot holes were filled with white metal whilst the pins were in, after which no more trouble was experienced.

A 20-off pattern, weighing about 18 cwts., required a box 4 ft. 6 in. × 4 ft. × 2 ft. 9 in. deep, for turning over. A 4-ft. sq. frame was found of the right depth, and two extension pieces to give the additional length were inserted. This served the purpose, and as the top presented a flat surface, odd top parts were used and staked at the corners.

Box Handles.

For heavy boxes the safest lifting handles are those cast in the side of the box and shaped like a fender. Such handles in this position serve many useful purposes. For example, if there is a heavier lift at one end of the box a chain hook can be placed on the outer end of the handle, thus shortening the chain without twisting it. Another useful purpose served by these handles is the ease with which they can be packed if there is only a narrow margin of bearing between the mould and the box edge. If a plate is bedded underneath the handles before taking off the box when finished with, and replacing it again, packing can be inserted between the plate and the handles before placing in position the holding-down weights, or a plank can be placed along each side of the box spanning the two handles and then by ramming between the box and the plank run-outs can often be prevented. Obviously these planks should be removed as soon as possible after casting to prevent burning.

Ease of turning over the box is another advantage. Handles on top, in the author's opinion, are not so useful, as they serve no other purpose but lifting. They are useless for turning over boxes, and quite often in the way of packing chaplets or weighting down. Flanges cast on the sides of the boxes for lifting purposes, using dog hooks, are suitable for narrow boxes, which are turned over on trestles near the job, but are not suitable for transporting about the foundry, as they easily slip.

Weighting Boxes.

When using two or more top parts for the one casting a bad joint on the casting is sometimes produced through one box having sunk lower than the other. To avoid this it is good practice to

* A Paper read before the Burnley Section of the Lancashire Branch of the Institution of British Foundrymen.

bed a weight on the joint, the weight being sufficiently long to catch the end of each box. If three boxes are used the same principle applies to the other end, and when putting bearers on the top for holding down weights it is esseutial to see that they reach well on each box away from the joint, and to pack the ends under the bearers after all the weights are in position. For a deep casting having only a narrow margin of bearing between the box and the mould, and necessitating a heavy load of holding down weights, it is advisable to put two other weights under the box edge on each side, and in cases of this kind it is advisable to bed a plate for each lot of weights below the bottom face of the casting, and to build up the joint to this.

Lifting Grids.

Patterns necessitating a deep lift under the top part are often too deep for the gaggers available. In such cases lifting grids are necessary. These are made similarly to core grids, provided with prods and wrought-iron staples. If the lift is a side joint, such as a large diameter pipe, which necessitates usiug the flat top, after having made the down joint and top joint, a thin layer of facing sand should be put on the bottom joint and grids bedded on. The job is then rammed up to the top joint, inserting straight irons where necessary in order to strengthen the side of the joint.

When ramming up the grids some preparation should be made for packing the grids to the box bars before starting to ram up. Hook bolts should be put in the staples in the grids, and the grids packed under the box bars. When rammed up, fishplates are put on the bolts and screwed up tightly. If the deep lift is on the pattern and there is a good surface of metal, it is preferable to pack the grids away from the pattern, and to allow a space of 1½ in. to 2 in. between, so that one can insert gaggers through the grids on to the face of the pattern. The reason for this is that there is only a thin layer of facing sand between the grid and the casting, and it invariably boils off or scabs unless well dried, but drying does not necessarily ensure good results, on account of the grids expanding on heating and contracting on cooling, which leaves cracks on the face of the mould resulting in the sand shelling off from the grids.

Deep Lifts and Grids.

For such deep lifts incorporating grids and where doubt exists as to the possibility of turning over the mould, it is advisable to put clamps or fish plates on the side of the box and pack it with boards or stays from these to the joint on the opposite side of the box to the chains. Such an arrangement also serves for deep cores, such as are necessary for headstocks, etc.

In cases where a pattern incorporating two different heights such as gap-lathe beds, slotting machines, etc., where it is more convenient to use two boxes, one for the lower and one for the higher level, a grid or plate with prods will be necessary to fasten on the end of the lower box, in order to carry the sand to the height of the top joint. Such plates are usually bolted to the end of the box. If there are no holes cast in the box they have to be drilled in, to suit the holes cast in the plate. A better method when making the plate is to cast two lugs on each side, these being provided with a wrought-iron staple, the distance between the staples should be equal to the depth of the end of the box to which they are to be fastened. The height of the staple from the face of the plate to the inside of the staple should be equal to the thickness of the box end plus 1½ to 2 in.

The plate is fastened on the end of the box, and an inch wrought-iron bar is dropped through each pair of staples, and wedges are placed between the wrought-iron bar and the box, the whole being wedged up tightly. If the space between the staples is wider than the box edge, it must be so packed that it cannot move. It is additionally necessary to ascertain that there is sufficient depth of joint to allow the lugs to miss the pattern.

Gating of Castings.

The method of gating and running castings differs in most districts, but the basis of the author's practice is to run heavy castings as quickly as possible, especially where there is a large surface of metal. It should be stated that the author's experience has been mostly with heavy and light tool and engine work, and his remarks will be confined to this class of casting.

Machine Tool Castings.

On receipt of the pattern, the surfaces to be machined must first be ascertained, and whether such surfaces are to be used as slides or bearings for brackets or standards. With this knowledge an endeavour is made to keep the runners as far from the machined parts as possible, as dross is usually to be found in close proximity to the gates. Base plates are usually run from the bottom at one end, the size and number of runners being decided by the weight of the casting, and the distance the metal has to travel. The down-gates from the joint to those leading into the mould should not pass through the top, but should be supplied with two others rammed up in the top a little distance away. The runners leading into the casting should be of a little larger area than the down gates, in order to allow the metal to flow into the mould more easily. In the case of small lathe beds having facings cast on for the standards it is advisable to ram a lump in the top at each side, and to cut sprays from the top of the facing into these, and then make the metal rise through the top. This often prevents blowholes and takes away most of the dross. They are, however, only necessary at the runner end of the casting.

Planing Machine Tables.

The author at one time rammed such castings at one end with what are known locally as "fountain gates." Fountain gates require much skill to put in properly, but no matter how done, a fair amount of risk is always associated with them, for if they are too near the sides dirt is liable to get in the machined parts, which is a sliding surface. The method does not appeal to the author as being a clean way of running, unless they are fed from a receiver. After discarding this method, the author ran them from the middle of the top with round gates through the cores. This method gave excellent results, as the gates were some distance away from the sliding surface.

The number of gates required is determined by the weight of the casting. A good rule to follow is to put on too many rather than too few, as the running can be regulated by covering a portion of the number with stoppers, and others with pieces of tin provided with small holes running through the centre and fastened down with sprigs. This enables the runner box to be full before much metal enters the mould, and prevents the dross from entering.

Large Uprights for Slotting Machines.

When these castings are provided with a deep foot they are best run from the opposite end to the foot, as it largely saves the strain at the deep end.

Large Face Plates for Lathes

Up to 8-ft. diameter, which are made in sand from patterns, are run with round gates on the top about midway between the boss and the run. Others, however, are made in loam from strickles. For these the author had to put in-gates built in the brickwork on the outside, level with the bottom of the mould, and then run out of the reservoir, which is built up separately and covered with a small loam-plate, and the whole cast with the down-gates.

Large slides for lathes and other castings that require to be machined all over the top and bottom are best run from a reservoir.

Planing Machine Cross Slides.

Cross slides for planing machines are run on the top at one end with small round gates, if there is sufficient space between the gates and the machined parts. If not, the reservoir should be used.

For such castings as are made in sand and are run from a receiver, the block for the reservoir is rammed up with the pattern, with an ingate connecting it to the bottom of the pattern, and the down gate is rammed on the top of the block or is

broken at the joint. The area of the down-gate must be larger than the area of the in-gate, otherwise the object of the reservoir is defeated. Difficulty once arose with 20-in. dia. plated pulleys having a 6-in. deep rim. These were run on the boss, and when machined they were dirty or porous on the rim opposite to the centre plate. To overcome the difficulty they were then run with "V" sprays from the top edge of the rim, and no further trouble was encountered. This method is also applicable to small pulleys having bosses which leave very little sand between the boss and the rim.

Spur Wheel Castings.

Toothed spur wheel castings have also shown porosity in the centre of the tooth directly opposite the arm, and it appeared that there had been too much blacking there, and it had run along the arm with the metal. They were of 3-ft. dia. and run on the boss. As a remedy, the author put a sprig in the centre web of the arm between 3 in. and 4 in. from the rim, which proved effective. Some of these castings are made from strickles in loam, the arms being formed with cores. The teeth were cut out from the solid, and occasionally the same trouble appeared, but was similarly overcome.

A good method for blank wheels with arms formed with cores is to connect the cores at the end of the arm next the rim with a piece of sand half the thickness of the arm at each side of the core.

Engine Castings.

Cylinder covers and piston blocks have been run from a reservoir with continuously good results. Cylinder liners and the like are cast on end and run from the top if there is a clear course for the metal to fall and the mould is dried.

Feeding Castings.

It has been stated that a mould incorporating a large number of cores does not require to be fed on account of expansion of the cores, but after the return of one or two large castings exhibiting porosity after machining or hollow places where the metal has been drawn away by a thick body of metal, the question arises as to whether the above argument holds good. When feeding castings having a good thickness of metal, or for a casting having to withstand steam pressure, it is advisable always to have ready some hot metal for feeding purposes, and to continue feeding as long as possible.

Casting with Two Ladles.

For the casting of a 7-ton job utilising two ladles of 5 and 3 tons capacity and one crane, a thick layer of straw was placed on the top part and a runner box holding 50 or 60 cwt. of metal was employed. The casting in this case was a 48-in. headstock and two stoppers covered with a thin layer of loam, in order to stop the down-gates, were used. The runner box was then filled from the 3-ton ladle. The ladles were then changed, and when the second ladle was in position the stoppers were lifted. The accumulation of air in the mould caused an explosion. This shook the sand from the sides of the runner box, which caused trouble, but fortunately the casting came out successfully. For a second casting, in place of the straw a thick layer of cinders was used with the same result.

Still a third method suggested itself. The in-gates were placed at the bottom of the casting, one on each leg, and were fed by a long spray-gate from the centre down-gates. At each end of the spray-gate an open riser was made through the top part, and bushes were installed almost level with the top of the runner box. When the stoppers were lifted there was no explosion, the air coming through the open risers.

Cross-Slide Castings.

Another casting which presented interest was a cross-slide weighing about 6 tons. It was cast by means of two ladles and two cranes. Gates at each end at the bottom of the mould were cut. Casting was started at the end, fed by the larger ladle. When the contents of the second ladle was added no metal went out of the runner box because the first flow of metal had rushed into the bottom gates at the other end and choked them. The lesson to be derived from this is, unless pouring is started simultaneously with both ladles it is dangerous to put both in-gates at the bottom. It is preferable to run the casting on end from the top, or in the case of a bed plate the gates should be put at one end about half-way up.

Facilitating Egress of Air from Cores.

It is advisable to provide the mould with many ways for the free passage of air, and if a long distance has to be travelled, the author never hesitates to put one or two pipes through the metal where there is no pressure of steam or water and no machining. In this category come castings such as planing machine uprights. In the case of standards for engines, carrying three or four cores, which join together and cut through at each end, some moulders connect all the cores with pipes, and in such a case the air is only taken out at one end. This might result in an explosion through the metal getting into one of the pipes, and obviously giving a bad casting. The author invariably insists on the gas being taken out at both ends, as cases have occurred where the metal has entered one of the pipes, but the air has been able to escape from the other.

Chaplets for Holding Down Cores.

Crossheads for vertical boring machines were usually cast successfully, but in one case it was found that the cores had lifted. The first conclusion arrived at was that the moulder had failed to put wedges on the chaplets. This he contradicted. There was only a $\frac{1}{4}$ in. of metal instead of $1\frac{1}{8}$ in., and on removing the cores it was found that the stems had been wedged but the plates beneath them had sunk into the cores, assuming the shape of a saucer. These plates were made of hoop iron, and were $2\frac{1}{4}$ in. × $\frac{1}{8}$ in. × 4 in. long, the stems being $\frac{5}{8}$ in. round iron.

After this experience two plates were placed on the top, and if it was not thought to be safe, the plates were bedded in the cores before they were dried. This method was always successful if they were put in the correct place for the stems. If cast-iron plates were used, a hoop-iron plate was always placed under the stem in case the cast iron broke after contact with the hot metal.

A further illustration is that of casting jobs on-end with a barrel core. Such castings are best fastened at the bottom, as it leaves the barrel free for expansion. Some, when stripped, are crooked in the bore, especially when they have been weighted down from the top, which caused the barrel to bend sideways. If it is impossible to fasten them at the bottom, it is preferable to put a strong fishplate across the top and bolt to the handles of the box, ascertaining that the bolts are provided with a long thread so that when expansion starts the bolts can be loosened two or three threads at a time until the metal has set.

DISCUSSION.

Mr. Pell asked for further information as to the chill used on the face-plate for lathes.

Mr. Bickerton stated that the hole in centre of casting was 9 in. dia., and instead of making an ordinary core he made a cast-iron bush, 9 in. dia. and $\frac{1}{2}$ in. thick, provided with a $\frac{1}{2}$-in. wide slot from top to bottom to allow for the contraction of the boss of the face plate. The inside of bush was rammed up with black sand, the outside was washed over with blacking, dried, and cast in like a chill.

Mr. Pell asked how far would that chill in the depth of casting. It would not chill in above 32nd of an inch in his opinion, and he failed to see that it would do any good, as the casting would have to be machined afterwards.

Mr. Bickerton agreed the casting might have been passed without the chill, but his reason was that the instructions were that the metal must be of close grain at the boss for boring, as there was a thread to be cut in it.

Mr. Pell replied that if it was only to act as a densener it would be thick enough to make the iron of a closer grain to obtain a finer thread. But, as far as he could gather, the thickness of chill used determined the depth of chill in the casting. With reference to long ram mentioned by the author, he had had some experience in

making rams and square retorts cast on end in the manner described, which incorporated no top plate, but merely a ring over the recess head, and that acted as a runner box as well.

Mr. Bickerton replied that he used a cross head on the top to hold core down and to keep it in the centre and a runner box at one corner, and when casting it he took care to stop pouring soon enough, so that the metal did not run over the top of the box.

Mr. Pell asked why a top plate was not used on that job.

Mr. Bickerton replied that there was a feeding head of 18 in. to be cut off, and he thought it was simpler and better to cast it open.

Mr. Pell asked if there was any advantage with having it open instead of using a top plate. There are many firms who will not allow for 18 in. to be cut off such a casting unless it was taken back at the selling price.

Mr. Bickerton said they generally took back feeding heads of that size, and allowed the selling price in return; and that, in his opinion, it was better both for buyer and seller, for if the casting was rejected through not being properly fed both would be losers.

Mr. Shorrock said in his own shop he had done the same sort of thing as Mr. Bickerton had been explaining. On the question of the chill, he agreed with Mr. Pell, but he did not take it that what was done really amounted to chilling. It was just a matter of closing the grain.

Casting Temperatures.

The Chairman (Mr. Hogg) said Mr. Bickerton had not touched upon running temperatures, and he would appreciate the author's views. Did he believe in running all castings very hot, say, dazzling white, about 1,500 deg. C., or bright white, about 1,400 deg. C., or medium hot, or on the dull side? They were all agreed, he thought, that they got smoother castings by running the metal dull. Mr. Bickerton had mentioned both bottom and top running. He, personally, had run from the top beetler bowls 16 to 18 ft. long, and they had always turned out very clean. He had tried running rollers at the bottom, but he was still a believer in running at the top. Speaking of pulleys, he had the same experience as Mr. Bickerton. They were dirty or porous on the rim opposite the plate, and he changed from running them at the top to bottom pouring. The results were fairly good, but after hearing the lecture he thought he would again try running at the top. Did Mr. Bickerton believe in running fly-wheels on the boss or on the rim? He had tried both ways, and got varying reports, but he thought the best results followed from casting on the rim. Mr. Pell was quite right in suggesting that with such a chill as was described there would not be more than a 32nd of an inch affected, and that it acted as a densener. He was a great believer in putting in a densener provided it was in the right place.

Mr. Bickerton said cylinder liners and gas engine cylinders he ran as soon as he could get the metal from the furnace; but he was under the difficulty at the time that the melting resources were poor. He could not get the metal too hot for the job. With regard to work that had to be machined all over, such as slides and pulleys, he always made it a point to run them just medium. He allowed the metal to come down as hot as possible, then let it wait until it started to "break," and then he ran it. His experience of round castings was that it was better to run them at the top. Where they were machined all over it was not very convenient to run them at the top. When running at the bottom he had a receiver, and if the metal had dirt mixed with it that was kept in the receiver. In other cases, when running them at the top, the dirt was always rising to the top, one kept raking it up and allowing it to come off.

A vote of thanks to Mr. Bickerton was passed unanimously, on the motion of Mr. Pell.

The Alma Foundry Company, Limited, are being wound up voluntarily. Mr. J. E. Bird, Gluman Gate, Chesterfield, has been appointed liquidator.

British Cast-Iron Research Association.

Lord Weir on Improving Trade.

The annual general meeting of the British Cast Iron Research Association was held in London at the Institution of Mechanical Engineers, last Thursday. Lord Weir presided and proposed the adoption of the first annual report which covered the period since the Association was incorporated in 1921. The report claimed that the Association existed to promote co-operation among iron founders with a view to carrying out industrial and scientific investigations relative to the production, treatment, manufacture and uses of cast iron.

Lord Weir said, as to the necessity of the Association, there was not a shadow of doubt as to its ability to meet the needs of the industry. There was no more useful field for research than was available in the iron foundries of the country, and the Association might reasonably claim the strongest support from the foundries. No association could be a success if it had to deal with an inarticulate industry, nor could co-operation be promoted without enthusiasm and keen interest. Lord Weir added that he was alive to what was restricting their trade to-day—the povery of some of their foreign customers. He was quite conscious the depression would not lift unless they themselves played a big part in lifting it by better processes and methods, by making fewer bad castings, and by decreasing their costs and so reducing prices to what their customers could afford to pay. In no branch of engineering was it so difficult to obtain a reliable explanation and effective permanent cure for any specific trouble than in connection with foundries. There were signs of a slight improvement in trade, a quickening of activity, but to a large extent it rested upon their own efforts, especially by brains and systems against any rule-of-thumb method. They should not be afraid to put up establishment charges if by so doing they could bring down the total costs.

The report was adopted.

In order to have a better geographical representation the following were elected to the council:—Messrs. J. Haigh (Wakefield), Major J. S. A. Walker (Wigan), N. B. Ellington (Chester), Major C. Howl (Tipton), S. H. Russell (Leicester), W. R. Bates (Irthlingborough), W. H. Whitehouse (Letchworth), T. Donaldson (Southampton) and H. Shannon (London).

Sir Frank Heath, secretary of the Department of Scientific and Industrial Research, emphasised the importance and the value of the work of the Director of Research Associations. His success rested on his ability to interpret the needs of the trade. Members of the Association must extend the possibilities of the Association into the industry. Their industry was up against the competition of America because of the better technique which existed in the foundries of that country. And they were up against the competition not merely of better technique, but up against the competition of new methods altogether.

To illustrate his point, Sir Frank Heath quoted the case of the printing industry. "You would not call the printing industry a laggard industry," he proceeded, "yet in the printing industry there is growing up, and will be placed upon the market, new methods, dealing with type in the production of newspapers and other publications by which type will be produced on a radically different basis from that hitherto adopted. I refer to the extension of the "Photogravure" system of the reproduction of type. I remember when I first saw the process applied to photographs I said you will not stop here. I was swept away with a thousand and one reasons against any extension. I was an ignoramus. To-day that machine exists in America. That is a lesson which every industry ought to bear in mind."

Concluding, Sir Frank said that industries in the future would be conducted upon an extremely narrow margin of profits, and the only possible means of success in the future would be upon a radically different attack upon the solution of the problem, and that was what would give the chance to the ingenious man, the inventive man, the scientific man.

An Apprenticeship Course in Foundry Practice.—XX.

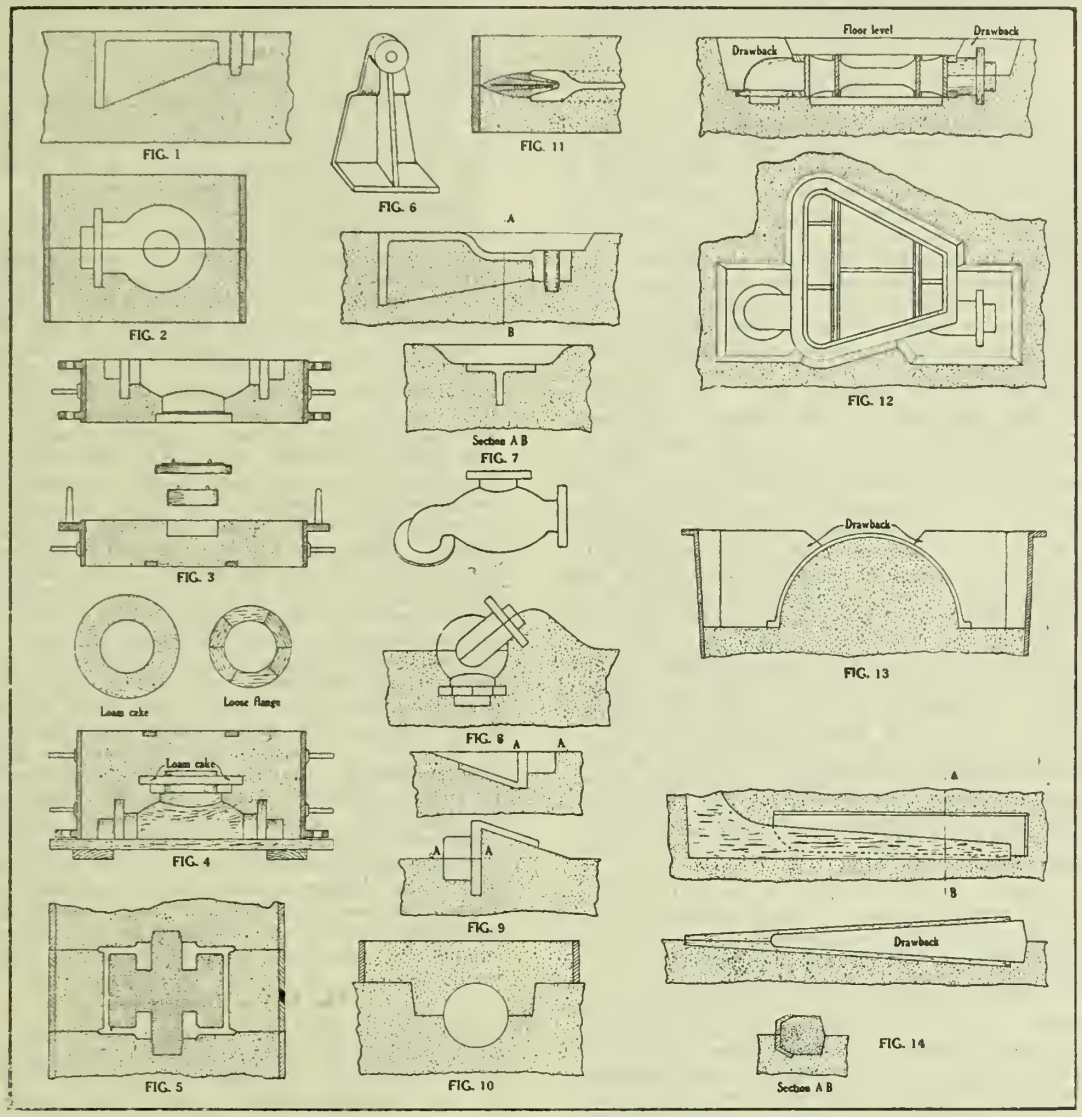
By Ben Shaw and James Edgar.

JOINTING OF MOULDS AND THE MAKING OF DRAWBACKS.

All closed moulds must be separated in the course of their preparation after they have been rammed up. This is necessary in order to withdraw the patterns and also to introduce any cores that are required to give the requisite shape to the moulds. Thus, a mould is composed of sections which, when assembled, form the whole mould, and, just as the division of a pattern into a number of sections to facilitate withdrawal from the sand is known as the jointing of the pattern, so the expression is also applied to the division of a mould. Moulding boxes are jointed, the number made. Usually the jointing is governed by the construction of a pattern to be used, yet there are innumerable instances in which the moulder is only indirectly influenced by the jointing of the pattern, when he must determine and fashion his joints to the best advantage with the available boxes or tackle at his disposal. Very closely associated with the jointing of moulds is the use of drawbacks.

Question of Special Equipment.

In the production of standardised castings it is profitable to prepare special equipment in order to reduce the actual labour involved in the preparation of the moulds, for the increased rate of



of joints depending upon the number of parts into which a box is divided, and each part carries pins or pin holes, in order that it will register accurately, when it is necessary to replace it in its proper relation to any other part or parts. The joints of the box parts may coincide with the joints of the mould, and be on the same plane throughout, or they may have little reference to it except to give a definite level surface, from which the proper joint of the mould can be more readily formed. The joints of the moulding boxes, therefore, provide guides to a certain extent which assist in the formation of the joints for their moulds. The joints of boxes are generally parallel to each other, each being in the same plane. There are exceptional types of boxes which have shaped joints, but these can be used for special work, and their use is limited. The joints of moulds, however, vary with the particular needs of the patterns from which the moulds are to be

production soon compensates for its additional cost. In such cases, drawbacks are very rarely used. When the number of castings required from any given pattern does not warrant the preparation of special equipment, then available tackle must be employed, and drawbacks are frequently necessary to divide the mould into convenient sections, either for the withdrawal of the pattern and insertion of cores, or in order to render parts of the mould more accessible. These drawbacks may rightly be termed cores when they give shape to the internal parts of a casting, or the expression "false-cores" may be applied when they represent part of the external shape of the mould. But the general term "drawback" is usually applied to those parts of a mould which are lifted separately and without the use of a box part, because they are drawn back to free the pattern or the mould. For work of a repetition character, the skill involved in forming the most

suitable joints is confined largely to the preparation of the equipment for dealing with the work, much time, as well as skill, being used, so that in making subsequent moulds, skill will be sacrificed for speed. On the other hand, when no special tackle is involved, there is the continual need for skill in the jointing of the mould for every casting so produced, the degree varying with the intricacy and sometimes the size of work to be done. The correct jointing of a mould is a fundamental asset, and the faculty for doing so from any class of pattern and for any type of mould is an indication of the skill possessed by the moulder; and the progressive student, realising the necessity of broadening his outlook on this important feature, will take every opportunity of widening his experience, and not be content to be guided solely by the work that comes directly within his scope, but will make himself familiar with the methods adopted for all work, intricate or otherwise, done in the foundry in which he is employed. He should be observant not only of the jointing of moulds, but of all processes and methods by which sound castings are produced.

Flat Joints.

These represent the simplest form of mould joints because they coincide with the joint of the moulding-box and frequently with that of the pattern. The whole mould may be carried in the drag, and the upper surface may be flat and covering the whole area of the mould. The cope in such an instance simply carries a flat body of sand which is flush with the joint edges of the box part. Thus in Fig. 1, which represents the section of a mould for a bracket, the upper part of a pattern should coincide with the joint of the moulding-box, and the sand between, forming the joint, should be perfectly flat. For small and medium-sized work of this character the drag is preferably made in an inverted position on a ramming board as previously explained. The same method is involved in preparing the valve mould in Fig. 2. This is another instance of a flat joint, but one in which the mould joint coincides with that of the pattern as well as the moulding-box. While this method of moulding is suitable, when the divisions in the valve body are vertical to the joint of the mould, many valve bodies have their division plates concentric with the valve, and these invariably need to be moulded with the valve branch in the cope, drag, or middle part, according to the method adopted and the available boxes. In this case three parts may be used, and the two joints may be perfectly flat, as in Fig. 3. When the flange is very close to the body there is greater difficulty in supporting the sand, and a suitably deep middle-part may not be available. The joint must then be varied to suit, and it ceases to be a flat joint.

A deeper box-part may be used to take the bottom half-impression, which carries the valve branch, and it can be rammed up to form one part, providing the branch flange has been cut into segments, so that they can be drawn into the mould after the main pattern body has been withdrawn. This is not a very satisfactory way, and it is questionable whether any time is saved over the preparation of a three-part mould, excepting when the valve is of considerable size. A better method is indicated in Fig. 4. It is useful when the pattern flange fits closely over the core print. During the process of ramming-up, a joint is made about the outside of the flange and flush with it. The loose flange can be stripped and a previously-prepared loam-cake, or core, laid on the joint and covering the flange impression. In this fashion the mould can be completely rammed up. The loam-cake used should be dried, and that part which is to receive metal should be blackwashed. This method preserves the flat joint between the two parts of the mould.

Another instance of the use of flat joints is illustrated in the three-part mould for a shrouded boxed-pulley shown in Fig. 5. This method is only possible when the depth of the middle box part is similar to the distance between the centres of the flanges; otherwise, either a raised or dropped joint becomes necessary. In specialising in the production of such castings, it is better to provide middle parts which will give flat joints, because they can be more easily prepared on a ramming board.

Irregular Joints.

When the joint of a mould must conform to the horizontal surface of its pattern, which is not continuous and in the same plane, such as the bracket in Fig. 6, then the mould joint must be lowered below the joint-surfaces of the box, in order that the cope will take the impression of the whole surface of the pattern. This is one form of irregular jointing, and it is very important that the change in shape from the level surface to the lowered contour of the pattern should be gradual, or, when one abrupt change is desirable, a considerable taper made between the two surfaces. The major part of the joint may coincide with the joint of the box, but the more gradual the depression is made the less is the difficulty in making a clean lift in the cope. Fig. 7 shows two sections of the mould illustrating this form of joint. In other instances the pattern supplied may be jointed, but subsidiary parts made to the joint may necessitate a variation in the mould-joint to accommodate it, or the parts may be set at an angle to suit a required casting. Here there is the same necessity for varying the joint-surface of the mould, one method being illustrated in Fig. 8. It will be noted that the flange carried in the drag is cut for drawing into the mould after the main pattern section has been removed.

Although a pattern may be in halves for convenience in withdrawing from the sand, the joint of the mould does not necessarily coincide with the pattern joint. The two sections in Fig. 9 illustrate the method for jointing the mould for a fair load, the pattern for which is jointed at A. A. When the web is cast in the drag, the joint is lowered and an increased lift made in the cope, whereas the alternative method reduces the lift. The need for irregular joints is common, whether the moulds are made entirely in boxes or prepared in the floor and simply covered, with this difference, that frequently when the latter method is used only a comparatively shallow cover-box is employed carrying bars which come very near to its joint surface. Because of this it is necessary to drop the mould-joint in order that any impression required to be carried in the cope, other than a flat impression, will project from the joint-surface of the cover-box. Thus, in cylindrical work, it is frequently necessary, owing to lack of box equipment, to set the pattern into the foundry floor, so that its highest parts are flush with the floor level, and the joint of the mould must be carried to its centre, as shown in Fig. 10, the cope impression projecting from the cover-box and supported by lifters or grids. Care must be taken when making sunken joints of this type to keep the joint level with the centre of the pattern and for a reasonable distance at each end of the pattern, before the change is made to the box joint level. This is necessary to prevent an acute corner in the cope lift, which is a weakness in a joint which should be guarded against in all forms of moulding.

The Use of Drawbacks.

Drawbacks are particularly associated with moulds which are prepared in the foundry floor, or in cases more or less permanently located in the foundry floor. They are nevertheless used when necessary when the moulds are prepared in boxes, although not to the same extent. Their special advantage is in forming loose parts of moulds to reduce the necessity for many box-parts. There is also a saving in pattern or core-box modifications, which would otherwise be necessary in many cases if no drawbacks were to be made, and, incidentally, they give a certain amount of freedom to the moulder to vary the preparation of his mould according to the tackle at his disposal.

A very common type of casting for which a drawback or false core can be profitably used are sheaves or pulleys for chains and ropes. They can, of course, be made in three-part boxes, but two-part boxes are usually sufficient for the purpose, providing the central part of the mould is jointed and carried as a loose piece in the manner indicated in Fig. 11. In this instance the loose part of the mould, necessary to free the pattern, is not lifted separately, otherwise it would need to

be substantially rodded, but it is supported by the drag until the top half pattern is withdrawn, the cope returned and the whole mould inverted, so that the loose-piece may rest on the cope, when the drag is lifted for the withdrawal of the remaining part of the pattern. The loose-piece should be well nailed and vented. This method is suitable for sizes of pulleys which, when made in boxes, can be easily turned over; for larger ones it is customary to make a block pattern and use sectional cores, or sweep an impression to receive cores for the arms as well as the groove about the periphery.

Drawbacks are frequently made when the lift to be made with the cope is excessive, when there would be a possible danger of its collapse when turning over, or when an unnecessary amount of lifting or gridding would be necessary to support it, and also when there would be difficulty in closing the job, owing to the parts of the mould engaging before the guide pins register their correct relative positions. In such instances, the deeper parts of the lift are prepared as loose pieces or drawbacks, so that when the comparatively flat cover is removed they can be lifted separately to free the pattern. Such an instance is illustrated by the section and plan of a mould for the water-end of a condenser, shown in Fig. 12. Here it will be noticed that drawbacks are used to form the cover for each branch, and the joint for the cope is dropped below the floor level, so that a better body of sand may be carried in the drawbacks.

In preparing the moulds for large semi-circular castings, having joint flanges which must be cast in the bottom, it is necessary to make use of drawbacks, particularly when the mould is prepared in the floor. The pattern may be of such a character that the main core can be made in the mould, as shown in Fig. 13, but whether the core is made from the pattern or separately, it is necessary so to joint the mould, not only to free the pattern, but to give access for sleeking or blackening. The drawbacks, in such instances, are usually separated from the pit or case until they are assembled preparatory to casting, when sand is rammed behind them. To enable them to be lifted, bottom-plates are preferable, and thin cast-iron plates may be set up vertically at both ends at the back of each drawback, against which the sand can be rammed.

In some classes of work it is preferable to make the pattern similar to the required casting, because of the difficulty of obtaining a reliable shape otherwise, and instead of boxing up the pattern and providing core boxes, cores are made in the form of drawbacks. This method is frequently desirable with large steel castings, an example of which is shown in Fig. 14. It will be noted in this instance that the drawback is raised above the joint of the pattern and the main part of the mould.

When the cope is removed, half of the pattern can be lifted; the remaining part of the pattern can only be withdrawn after the drawback has been removed.

The majority of moulds for large work, which are prepared in pits or cases, depend largely upon the utility of drawbacks, which facilitate the removal of pattern sections and give access for cleaning the mould and introducing cores.

Mr. R. Bell, of 73, Drury Buildings, Water Street, Liverpool, has been appointed agent in Liverpool and the North-West of England for National Alloys, Limited, of Ilford, Essex, for the sale of their "Altior" alloys of bronze and white antifriction metals.

British and American Capital Investments in Hungary.—Owing to the heavy depreciation of Hungarian currency more and more British and American capital is finding its way into the country. Thus, for instance, the American Morgan group has come to an agreement with the Manfred Weiss concern of Budapest, owning large ironworks on the Csepel Island in the Danube, to have their works thoroughly modernised. An unnamed British firm of makers of ventilators are to erect large works in Hungary for the sale of their manufactures in South-Eastern Europe and the Balkans. Mr. Harriman, the President of the United American Shipping Line, has arrived in Budapest with an American leading banker with a view to forming an American-Hungarian Shipping Company.

Nitrogen in Iron and Steel.

An academic research of great practical interest has been conducted by two German workers, Messrs. F. Wüst and J. Duhr, at the Kaiser Wilhelm Institute, and published in the second volume of the communications of this body.

After reviewing existing methods for determining nitrogen in cast iron and steel, the authors give a comparison of the quantities found by other workers. The authors condemn the Nessler method and have used those based on the conversion of nitrogen to ammonia by the action of a suitable solvent, which is titrated with a normal solution of H_2SO_4, using iodine or an ether solution of iodeosin as an indicator. Results for cast iron were 50 to 100 higher when using the former, as hydrocarbons do not interfere, as they are shaken into the ether layer in the iodeosin method. A number of finely powdered materials were subjected to a temperature of 900 to 1,025 deg. C. in a nitrogen atmosphere for several hours, and the quantity of nitrogen absorbed was determined by the iodeosin method. It was found that pure iron had taken up 0.02 per cent.; pure chromium, 9.81 per cent.; manganese of 97 per cent. purity, about 7 per cent. Nickel and molybdenum were both free from nitrogen. Amongst other conclusions reached by Wüst and Duhr was that the nitrogen content of puddled iron varied directly with the duration of the process. The pig-iron used contained about 0.0011 per cent., and the final product 0.0035 per cent. Dealing with the Talbot process, the nitrogen content is the same at the beginning as at the end of the process, and is returned at 0.002 to 0.003 per cent., though in some types of steel it may have been higher at some point during the heat.

Mild electric steel, in a Röchling-Rodenhauser induction furnace, taken in the liquid from the Talbot furnace, showed that the nitrogen content is raised to 0.004 per cent., whilst chromium and high carbon steels so treated increased considerably during this refining process, the former finishing with 0.005 to 0.008 per cent., and the latter 0.009 to 0.012 per cent. nitrogen. The nitrogen content is influenced by the additions; for instance, recarburising with coke increases the nitrogen from 0.002 to 0.010 to 0.012 per cent., whilst slag additions decrease and ferro-silicon reintroduces it. When experimenting with the basic Bessemer process the authors found that the nitrogen content (0.011 to 0.021 per cent.) was not affected by either solid or liquid deoxidisers.

It was also found that the nitrogen in iron does not exist as a cyanide, and no support was given to the theory that ferro-silicon acts as a carrier. From their experiments Wüst and Duhr conclude that the nitrogen is introduced into Bessemer steel by the air blast.

The Edinburgh Corporation have accepted the tender by the Leeds Forge Company, Limited, to supply 56 double-decked electric cars at a cost of £40,600.

Permanent Way Material for Portuguese West Africa.—A cable from Johannesburg states that two orders for Angola, the total contract sum amounting to £385,000, have been secured by Messrs. Robert Hudson & Sons, of South Africa, representing the firm of the same name of the Gildersome Foundry, near Leeds. The orders are for the supply of permanent-way material, including British steel rails. The first contract is for the extension of the existing Loanda Railway and the second for a feeder line.

Manchurian Steelworks.—Although the report of the American mining engineers who recently inspected the Manchurian coal and iron fields has not yet been made public, it is learned that as a result of their investigation, the South Manchurian Railway Company will proceed with their original plan of erecting a large steelworks in the Far East. The scheme as reported contemplates a consolidation of the Anshan Iron Mines and Steelworks operated by the South Manchurian Railway Company with the Penchihu Colliery and Steelworks, a Chinese-Japanese enterprise controlled by the Okura interests of Japan. The low-grade iron deposits in Manchuria are expected to yield profitable returns. The plant will be able to furnish all the steel products required for the extensions of the South Manchurian Railway system, the Chinese Eastern and Siberian railways, as well as other enterprises in China proper.

Institution of British Foundrymen.

LONDON BRANCH.

STEEL FOUNDRY PRACTICE DISCUSSED.

An ordinary general meeting of the Branch was held at the rooms of the Institute of Marine Engineers, Minories, London, on November 2. Mr. H. O. Slater (Past Branch-President) occupied the chair (in the absence of the President, Mr. Wesley Lambert, who was unable to attend through illness), and expressed his sympathy with Mr. Lambert. He then called upon Mr. F. A. Melmoth to read his Paper entitled "Notes on the Development of the Manufacture of Steel Castings."*

Maximum Aluminium Allowable.

The Chairman, in opening the discussion, said that Mr. Melmoth had put his points very clearly and concisely. When dealing with metal composition, Mr. Melmoth had referred to what he termed an excess of aluminium, and he (the Chairman) would like to know what he regarded as an excess. With regard to sand, it was his opinion that the author had skipped rather too quickly over that part of his lecture. Therefore, if the author would give them some of the mixtures of sand used, their names and compositions, he would very much appreciate it. Another point that interested him was cracking of steel castings. Did the author find that in some of his most intricate work it was almost impossible to eliminate the cracking unless the work were knocked out and put into a muffle, and allowed to cool that way?

Titanium in Steel.

Mr. V. C. Faulkner said that the Paper threw further light on a discussion they had had at the last meeting of the Branch, inasmuch as it had dealt with the "life" of metal, and the author's remarks confirmed Mr. Lambert's experience that temperature does not drop rapidly, but if liquid metal were allowed to stand, it would lose some of its life. With regard to the use of titanium as a deoxidising agent, when he had used it—perhaps it was not of the same quality as that used by Mr. Melmoth—he had found that it gave very hard spots in the castings in the machine shop. If he remembered aright, the quality of titanium he had used was poor. As to sands, he did not know whether they were aware of the fact, but quite a number of steel-casting firms had installed driers, in order to ensure that the sand which was the base for the work was perfectly dry. He knew that Messrs. Edgar Allen and Messrs. Thwaites did that. Under the heading of welding, Mr. Melmoth had said that the weld should have 80 per cent. of the ultimate strength of the metal of the casting. Usually, unless welding was followed by heat treatment, it was found that the weld was quite satisfactory, but that the material just at the side of the weld was very weak, and stress would result in the breaking of the material at the side of the weld. To put it practically, the material at the side of the weld had been burned. He had been very interested in Mr. Melmoth's general remarks, because the latest advices from America showed that, whilst the trade was only improving very slightly, there was already a dearth of skilled moulders, and Mr. Haigh, in his presidential address to the Manchester Branch, stated it as his opinion that, as soon as trade did get a little better, there would be a similar lack of moulders in this country.

Foundry and Drawing Office.

Mr. C. A. Otto said he was particularly interested in that part of the lecture where reference had been made to the design of a casting. He believed there were opportunities for the best type of boys working in the foundry to be drafted into the drawing office. He knew of one extensive works in the North of England where that practice was adopted. Occasionally a boy from the pattern shop or from the foundry was given an opportunity to transfer into the drawing office. The only disadvantage he (Mr. Otto) had found in that connection was that it meant that the better class of boys, who would really be more useful in the foundry trade, were taken into the drawing office and left the foundry entirely. Nevertheless, he believed such a scheme was advantageous to the foundry, because the boy who had been trained in the foundry was not taken out until he had had a good training in the principles of foundry work. He had attended evening classes, and had studied mathematics, geometry, drawing, etc., in order to qualify himself for a position in the drawing office, and had kept himself alive to the work of the foundry, in order that he might stand above other boys, and get an opportunity of being pushed forward. In doing so, he had become an expert moulder, or was on the way to becoming one. Finally, he asked Mr. Melmoth whether webbing was resorted to in mild steel castings which he produced, or whether he overcame the difficulty of unequal thicknesses by means of denseners?

Foundry Economics.

Mr. G. C. Pierce, dealing with general conditions in the foundry industry to-day, and the conditions under which those engaged in the industry had to work, remarked that Mr. Faulkner had said on a previous occasion that boys liked to go into the foundry because of the pyrotechnic display, and did not dislike dirt. He himself held an entirely different opinion, but felt that he would be out of order in discussing the subject. However, he would ask whether the author had considered how far the economic position of the foundry workers of to-day affected the question of its staffing with intelligent boys.

Carbon Content and Heat Treatment.

Mr. C. Cleaver, referring to the table of heat treatments and tests, said that, in the first place, taking the carbon content, he was under the impression that there was a definite annealing temperature for each point of carbon above a certain amount. He had noticed that the heat treatments of steels containing 0.16 per cent. and 0.24 per cent. were both at 900 deg. C. He had noticed also that with two steels of practically the same analysis (Nos. 5 and 6 in the table) there was a very wide difference between the yield points, one being 16.9 tons per sq. in., and the other 23.4 tons per sq. in., a difference of 33 per cent., and it did not appear to him that the steels could be uniform, although the analyses were comparable. He asked whether the author could say what had caused the difference.

Technical and Practical Co-operation.

Mr. A. R. Bartlett said there was one point that appealed to every foundryman, and that was the question of design. The weak point in connection with design, from the foundry point of view, was that they did not have a sufficiently close co-operation between the technical man and the practical man. The technical man, who thought he had all the knowledge that was necessary in order to enable him to get what was wanted, never asked the opinion of the practical man, because he probably thought the practical man knew something, and would pull him (the technical man) over the coals on some point which he (the practical man) looked at from the practical point of view. The practical man had the same timidity in approaching the technical man, because he felt he had not all the technical knowledge that the latter had. If they met on common ground, and had a common regard for one another, probably some of the difficulties of design would be overcome. With regard to the training of apprentices, that was always a sore point. They wanted to make better craftsmen, but there was a great deal of specialisation and standardisation, and when a man entered a specialised line of business he would not make a craftsman, but would develop into a sort of machine. The greatest difficulty they had to face at the moment was that the commercial side of the business must be considered; they must make things cheaply, and in order to

* This was published in the Foundry Trade Journal for November 2, p. 355.

do that they must go in for specialisation and standardisation.

Fluidity.

Mr. E. H. Brown, referring to fluidity, said there was much discussion taking place as to what were identical analyses. There were several elements which entered when dealing with steel, such as oxygen and nitrogen, and chemists were practically unanimous that there were no accurate means of determining them. Therefore, was anybody justified in saying that analyses were identical, having regard to the fact that there were sometimes included minute proportions of one of these, or other elements which were not estimated in the ordinary way? As to foundry training, he referred to his experiences on Tyneside. There he had interviewed about 60 boys during a year with regard to their employment in the foundry, and only two of them would even hear of going into the foundry at all. They usually said, first, that the foundry was too dirty, and, secondly, they considered that the foundry trade was a minor one, and that there was no future in it. He had tried to get boys with secondary school education into the foundry, but there seemed very little chance of this at present, unless they could do something to improve the foundry trade and make it appear in a better light. The machinist had the pick of the boys coming into an engineering works. He suggested that something might be done during their last few years at school to encourage them to go into the foundry. He suggested they might be shown films, in order that they might see some of the interesting work of the foundry, and then they would have a chance of considering it for, perhaps, two years before taking up the work. With regard to taking boys from the foundry and transferring them to the drawing office, this had the advantage of stimulating other boys in the foundry to improve themselves. Dealing with sand, he said that he had noticed during the Liège conference that one firm—he believed it was Messrs. Fondéries de l'Esperance-Longdoz—were turning out steel castings in green sand, and were endeavouring to utilise the old sand repeatedly and to maintain the sand practically entirely of a composition suitable for facing work. If they could do that in Belgium, we in England should endeavour to utilise our sand similarly, and to maintain it in the same condition.

Crucible Steel Castings.

Capt. Lindsay (a visitor) said the author had dealt too summarily with the manufacture of steel castings in crucibles. His statement was correct when applied to manufacture on a large scale, but he believed that it required qualification in so far as it applied to the manufacture of steel castings on a small scale. There he believed crucible melting was worthy of attention. He mentioned it at that meeting because, after all, in the London district the manufacture of steel castings on a large scale was not taking place, unfortunately. For the successful manufacture of steel in crucibles the nature of the furnace was of first importance. The crucible steel furnaces in use to-day were largely deficient in design, and he believed Mr. Melmoth would bear him out when he said that the coke consumption of these furnaces was excessive, the furnaces sometimes using 2 to 2½ tons of coke per ton of metal, whereas, with efficient forced-draught and correct distribution of air in properly proportioned furnaces, the fuel consumption could be as low as one ton of coke for one ton of steel. Under those circumstances steel could be produced at £10 or £12 per ton, and, where there was a limited demand, that was still an attractive proposition. The converter and the electric furnace, of course, played their part the moment the demand was sufficiently high, but for a small demand they all knew that those furnaces could not be operated economically and intermittently; therefore, the economic argument that militated against the use of crucibles for large demands was favourable to crucibles where the demand was small. He was referring particularly to the user of steel who wanted to make his own castings.

Mr. A. F. Gibbs asked for a little more light on the subject of heat treatment. In the first place, he did not know what substances were used for packing, but he took it that the author used a neutral substance, such as sand. Again, did the author have any trouble with warping during annealing? He would like some information as to the rate at which the temperature was raised in the annealing furnace, and also the rate of cooling. With regard to the table of results, he had noticed that in the second sample the percentage of manganese was rather high. He would have expected, with such a percentage of manganese, a rather higher tensile result. He was wondering whether that had anything to do with the grain size.

THE AUTHOR'S REPLY.

Amount of Aluminium Necessary.

Mr. Melmoth, in reply to the discussion, dealt first with the Chairman's remarks. As to the quantity of aluminium which he would regard as an excess, he had not mentioned a figure for that at all, but the usual practice, for electric-furnace steels, was to add a very small amount, probably somewhere about ½ lb. per ton of steel, in the ladle, and that was really added as a surety. He had cast large numbers of castings without aluminium from electric-furnace steel. For converter steel they would probably use 1 to 1½ lbs. per ton of steel in the ladle.

Preparation of Sand Described.

With regard to sands, he had not entered into detail purposely, because on every one of the headings in the Paper it was possible to occupy nearly the whole of the time available for the whole Paper. If the matter were of interest, however, the first thing to consider was the basis sand, and the finest basis sand he had found so far was Leighton Buzzard. It could be obtained in any quantity, it was wonderfully regular in grain size, and the most serious element, *i.e.*, fine dust, was almost entirely absent. Also, it was remarkably free from clay. Taking a sand of that nature, *perfectly dry*, at his foundry, they milled with it about a quarter of its bulk of the Cornish sandy loam mentioned in the Paper, which latter was obtainable in large quantities from Cornwall. They milled for about 5 to 10 minutes, and thereby produced a sand which, for green-sand steel castings, was the best they had found. If a finer finish were required, finer grades of silver sand could be used with the Leighton Buzzard. For dry-sand work they were in the habit of using old sand which had been passed through a renovator, which removed the dust almost entirely, and brought the sand down to a regular-grain size. To that they added a small proportion of Mansfield sand, together with a little binder, and milled for 5 to 10 minutes, and they had not found anything superior. They had tried other sands, but without any great success. They had given up the idea of using local supplies at the moment.

Cracking Troubles.

With regard to cracking, he was afraid that the Chairman would find, in his (Mr. Melmoth's) particular foundry, there were difficulties. There were mass-production methods. On full output they were producing from about 12,000 to 15,000 different castings per week in mild steel, and it would be found almost impossible to knock them out and put them into a muffle to cool. There was very little need for knocking them out hot and putting them into muffles—at least, with those with which he had dealt. In dangerous cases, the standard practice was to release all risers immediately the metal was cast. In reply to Mr. Faulkner, the author said that on the question of fluidity nobody had made any definite statement at all. He had read all he could find about it, and for over two years he had been trying to find out the fundamental principle. Mr. Faulkner's experience of making electric steel, and finding that when he tapped the steel it had not the expected fluidity, was quite common, and that was the phenomenon which had led him (Mr. Melmoth) to look further into the question. He had found that if they tapped electric steel when it was ready —and he supposed that applied to any metal—

and did not have any delays, they had probably the best possible conditions they were likely to get.

Fluidity Dealt with.

Working conditions in the electric furnace controlled, to some extent, the fluidity of the metal. Some academic gentleman previously had said practically that that was not so, and that fluidity was purely a function of temperature, given identical composition. He was afraid the practical man did not believe it, and he himself did not, from his experience. He sincerely hoped that in the near future the experiments carried out by his firm would be on such a basis that he would have the pleasure of giving the Institution the results. At any rate, they could, to a large extent, control fluidity in the electric furnace.

Low Carbon Titanium Useful.

With regard to the use of titanium as a deoxidising agent, no doubt Mr. Faulkner was working with some of the titanium obtainable before the war, and probably it contained a very appreciable percentage of carbon. He had used titanium, and had never had trouble through hard spots.

The Drying of Sands.

As to the use of a drier for sand, that was obviously the only way to get the moisture content regular. His firm had installed a Thwaites drier, and all their material was put through it. The old floor sand was put into the drier with a small proportion, probably 1 to 4, of new sand. When perfectly dry, it passed from the drier and dropped into a shoot, where it was riddled, and nails and scrap thrown out into a sump. The sand fell into a hopper, was caught by a blast of air, and blown straight up into a large tank. The finest dust went over the top to a settling tank, and by gravity the heavier sand fell into the main tank and was fed to the mills automatically. With regard to the runner for the test bar, if it was carried at its full thickness, or a little over, right up to the test bar, it was distinctly possible that a small draw would occur, through the runner itself drawing metal from the actual test-bar casting. By merely choking the runner they obtained a very much better test bar.

Welding and Heat Treatment.

As to welding, Mr. Faulkner's experiences were quite usual. Any weld which was carried out roughly and quickly was always oxidised round the edges, and it was common practice, and should be general practice, that after any appreciable welding, heat-treatment should be carried out; in most foundries welding was carried out before heat-treatment. An oxidised ring round a weld was a sign that the weld was a bad one. It was largely a question of defective workmanship. With regard to the lack of skilled men, to which Mr. Faulkner had referred, he was afraid Mr. Faulkner knew more about that than he himself did, but he knew that as soon as work did improve they could get moulders, but not the type they wanted, and it was largely due to the chaotic condition of boy training. There were no technical educational facilities for boys in his district, and his firm was finding that one of the most difficult problems at the present time. It was the experience of his own firm that during the war the boys were turned into small machines. They were put on the floor with jobs, of which they turned out two or three hundred, or in some cases two or three thousand, and they turned them out in exactly the same way as machines turned them out. They did not appear to have had very much training of the kind that would make them properly qualified and properly skilled moulders, and as a consequence the time would come when the foundry industry would feel the shortage of skilled moulders very severely.

Training of Apprentices.

Mr. Otto had referred to the taking of boys out of the foundry and putting them into the drawing office. That was all right, but he did not see that that would meet the point. If any initiative on the part of foundry people could ensure that the people engaged in actual designing had previously had to undergo foundry instruction, then a very different state of affairs would exist, but merely putting a boy through so much drawing-office routine, although it would help him in moulding practice, would not improve matters very much. The trouble was that defects in design were not always realised by the designer to be his own fault, but were said to be the fault of the foundryman. As to Mr. Otto's second point, any number of mild-steel castings had to be webbed up to prevent cracking. Chills hardly acted as denseners in steel. Chills were used quite freely on certain types of work, but there was no doubt that they added very materially to the expense of producing a casting, and any steps which could be taken to procure soundness without chills would be all to the good. His firm used a quantity of chills, particularly in places at which it was very difficult to get, such as heavy bosses. In many other cases an alteration in design had got over the difficulty without the necessity for using chills or anything else.

Mr. Otto, intervening, said that when he had referred to the apprenticeship system in vogue in a works in the North of England he should have made it clear that the boys who were drafted from the foundry became permanently established in the drawing office, and they had the opportunity, if they were sufficiently equipped, to become designers. He knew two such men who were designing, and who very rarely found it necessary to go to the pattern shop or to the foundry for their information. They had been trained in the principles of the work, and could follow it out much better than the average draughtsman, who had not had experience in the foundry.

Mr. Melmoth said he had the idea that the boys should serve in the drawing office for a time, and return to the foundry afterwards. He thanked Mr. Otto for correcting him.

More Economics.

Replying to Mr. Pierce with regard to the conditions in the foundry industry, the author said that Mr. Pierce had put the matter in a light that had not occurred to him, but if any industry, or any separate firm in an industry, could not produce a casting economically, and sell it, and, at the same time, guarantee decent conditions for its workpeople and for the boys who were growing up in the industry, then the sooner that firm or industry was out of it, the better.

Practical Heat Treatment.

Mr. Cleaver had pointed out something in connection with quenching temperatures which was somewhat academic. The academic gentleman would probably say that with a steel casting containing 0.18 per cent. carbon the A^3 point was 875 deg. C., and that if they heated to a temperature of 880 deg. C. they were 5 deg. over. For 0.22 per cent. carbon he would probably say the A^3 point was 860 deg. C., and if they heated to 870 deg. they would be over it. But in ordinary practice, said the author, the difference in temperature between 870 and 900 deg. for mild steel castings could not possibly do any harm. The figures he had given in the Paper were not academically produced; they were not laboratory figures, but were taken under works conditions, and under those conditions they did not expect a difference of a few degrees to make all the difference to the annealing of a steel casting. In the hardening of a high-speed tool steel or, say, an alloy-steel crankshaft, it was necessary, but not in the annealing of a mild steel casting. With reference to the point Mr. Cleaver had raised with regard to the yield point, that was obviously wrong, and was probably due to the fact that he had hurried when preparing his paper. A yield point of 16.9 tons per sq. in. was too low for such a steel, and it should have been in the neighbourhood of about 18 tons. However, it was probable, with regard to the figure of 16.9 tons, that the person carrying out the test got a false reading.

Effect of War on Training.

At to Mr. Bartlett's remarks with reference to co-operation between technical and practical men, there was, no doubt, a little fault on both sides. The practical man had a very great distrust of the highly technical man, until the latter attempted to meet him, but after that he would meet the technical man never less than half way, and in several cases he had met him a great deal

further. It was his own experience that the practical man would help the technical man, and it was only a case of going about the problem in the right way. The technical man who said he could carry on without the help of the practical man was romancing. With regard to specialisation, he believed Mr. Bartlett had misunderstood him. He (Mr. Melmoth) was grumbling about the fact that many boys were put on purely repetition jobs during the war. That was a very great error, and would have the effect of robbing the boys of nearly five years of the varied experience which he believed Mr. Bartlett would insist upon their having. He was not suggesting that that was the right way to handle boys; it was wrong. It was forced on firms under war-time conditions, but the moulder of the future would not be quite the man he was before those conditions obtained.

Belgian and British Sands.

Mr. Brown, in discussing fluidity and identical analyses, had said that because they did not know enough about a thing it was not worth while saying anything about it. On the contrary, it was only by discussing such problems constantly that they would ever know anything about them. With regard to the use of green sand over and over again in Belgium, Mr. Melmoth pointed out that green sand depended for its bonding properties on clay. If they baked clay they destroyed the water in it, and got nothing but silt, which became cumulative, and for steel castings it was even more important than for iron that the sand should be very open and porous. Mr. Brown has also suggested that it was curious that we could not do something to grade our sands in the same way as the Belgians graded theirs. That was a physical impossibility. The Belgian sands were naturally bonded, but in this country the naturally bonded sands were not of sufficiently open grain, in the silica portion, to be used for steel moulding. At any rate, if they were, he had never had any of them. Silver sands allied with a clay were the only moulding sands which were successful here for green work.

Cost of Crucible Melting.

He welcomed very much Capt. Lindsay's contribution to the discussion. His own firm had started their foundry as a crucible steel casting foundry. Capt. Lindsay was correct in saying that the old type of furnace, probably the Sheffield type, the 2 or 4-pot furnace, with ordinary induced draught, was very expensive to run, and no doubt his figure of 2 tons of coke per ton of metal melted was on the moderate side. On the other hand, the coke consumption figure for the latest type of Morgan furnace, which was a forced-draught furnace, and was recommended for melting steel for mild steel castings, was 30 cwts. per ton of metal melted. Even at 30 cwts. per ton it became a fairly expensive business. Capt. Lindsay was right when he had said that for small quantities that was a sound proposition. Certainly it was for those wishing to make their own castings in small quantities, but he would not like to go into the steel castings trade with crucibles. He pointed out that prices are falling. He had seen some very beautiful castings indeed made from crucibles, and he had no doubt with regard to either the material or the castings obtained from them, but he did not think that a foundry, as a profit-making business, could be run now on crucible lines. Another point was that they limited materially the size of the casting they could make, although they could double up if they wanted to for medium weight jobs.

Annealing Explained.

He was very much afraid that Mr. Gibbs was thinking of mild steel castings a little in terms of malleable when he had referred to packing, etc. The ordinary method of annealing mild steel castings was merely to raise them to temperature inside a furnace; they were placed inside as and when convenient, but a little consideration was given in the placing of them to any possible warping due to uneven heating or possible sagging of uneven portions. There was no packing required at all, because the actual heat treatment was not a chemical one; it was purely physical, purely a case of re-crystallisation. The as-cast structure which existed in the form of coarse crystals was heated to a temperature at which it should become a solid solution, and re-crystallised to a finer grade, the fineness of the grade being dependent on the temperature to which it had been heated. He had dealt with the question of warping, but many castings, variable in type and of variable thicknesses, had often to be packed up with pieces of brick in order to prevent sagging. The question of the rate of heating up of very mild steel castings were almost immaterial, but the cooling down depended very largely on the type of casting again, and was largely a function of mass. In the case of heavy casting it was obviously better to allow the casting to cool slowly in the furnace, but a large number of these small castings were cooled down in air from 900 deg. C. without developing defects. With regard to manganese content, that was not by any means too high, unless these steel castings were used for electrical purposes. For electrical purposes it was advisable to keep the manganese content down to about 0.35 per cent.; the carbon and manganese, in these cases, should always be kept as low as possible, whilst the effect of silicon appeared to be rather beneficial.

Dealing with the influence of manganese on grain size, Mr. Melmoth said that the tendency was for manganese to reduce the grain size in the as-cast condition.

Brinell Scleroscope.

MR. E. H. BROWN asked whether there was any advantage in using the Brinell test over a scleroscope reading for testing steel castings, or whether the scleroscope offered as good a test for comparative purposes as the other.

MR. MELMOTH said that he, personally, had not used the scleroscope on any mild steel castings, but, knowing the instrument, he saw no reason why comparative tests should not be obtained in the same way. The value of most of these tests existed absolutely in the fact that they were comparable, and the scleroscope should be just as good for comparative purposes as the Brinell.

MR. FAULKNER said he had found that the scleroscope gave a reading varying with the thickness of the section on which it worked.

MR. MELMOTH said the minimum thickness of a steel casting was about $\frac{1}{4}$ in., and he did not think any one would hesitate to apply the scleroscope test, assuming $\frac{1}{4}$ in. thickness of metal, and in this case they need not anticipate any appreciable movement of the metal which would affect the scleroscope test.

Cinema and Training.

THE CHAIRMAN said he was impressed with Mr. Melmoth's reference to the handling of the sand by machine instead of by hand, which was very hard work as a rule. With regard to the point raised as to the use of the cinematograph for the education of the moulder, or any other craftsman, he reminded the members that when they visited the Rugby works of the B.T.H. Co. they were shown the complete method of producing a steam turbine. That was most instructive to some of the old members of the Institution, and the cinematograph could very well be used by technical institutions to carry out the education of those who were going into the foundry.

He suggested that the Hon. Secretary should be asked to send a letter to Mr. Lambert, the President, expressing the sympathy of the members in his indisposition, and wishing him a safe voyage to America, and a successful time there.

Vote of Thanks.

MR. J. ELLIS proposed a very hearty vote of thanks to Mr. Melmoth for his very able lecture. It had been well discussed, and they owned Mr. Melmoth a deep debt of gratitude for taking so much trouble to prepare it for presentation to the members. He himself was delighted that Mr. Melmoth had introduced the question of the training of boys. That question had been worrying the Institution for a good many years. As the lecturer had said, boys would not come into the foundry, at least the right type of boys, but he was more than confident that, if they once got a boy into the foundry and gave him a fair run, he would find the trade fascinating, and if boys were

treated fairly the foundry trade would get a good number. Again, he considered that employers ought to be more public-spirited. Boys were being educated in the foundries, but if they progressed rather rapidly they left, and went to another foundry for an extra two shillings a week. If tho employers were public-spirited, they would realise at once they were doing a national work. They had the same chance of getting the boy from the other foundry, and he urged that every boy should be given a chance, and not kept on one class of work too long. Undoubtedly there was a great dearth of good moulders, and he often wondered how far the moulding machine was responsible for that. At the same time, there were some classes of work for which, he supposed, they would never be able to do without good moulders. There was an illustration of that at Messrs. Fraser & Chalmers' works, which the members of the Branch had visited in the previous month. Everybody would agree that there was certain work there which could never be put on the moulding machine, and therefore the moulder had something to look forward to as a really skilled craftsman.

Mr. A. R. Bartlett seconded. He had noted with very great pleasure, he said, that the lecture had drawn out a very good discussion, and that there was a fairly good gathering, which was all to the good, because he did not want it said that the London Branch was run by one or two people. He had noticed that in The Foundry Trade Journal recently somebody had remarked that people wanted to discover themselves; some of those present that evening had discovered themselves, and had given their opinions to others, which was helpful.

The vote of thanks was accorded with enthusiasm.

The Author, in thanking the members for the vote of thanks, said it had been a pleasure to give the lecture. He hoped he would have the pleasure of addressing the members of the Branch at a future date.

The meeting then closed.

NEWCASTLE BRANCH.

At a meeting held on October 28 Mr. Percy Longmuir, D.Met., of Sheffield, gave a lecture on "Iron, Steel and Brass Founding," with lantern illustrations. Mr. H. J. Young, F.I.C., Branch-President, was in the chair, and, in introducing Dr. Longmuir, congratulated him on his appointment as Director of Research to the B.C.I.R.A. He had been chosen out of a large number of applicants, and it was one of the most important positions in this country at the moment.

IRON, STEEL AND BRASS FOUNDING.

Dr. Longmuir commenced his lecture by saying that he wanted it to be more like a friendly talk, going from one aspect of foundry practice to another. He felt that in each member of the Institution he had a friend, and that he could get any help he needed from the foundries of this country.

Pre- and post-war there has been a great deal of talk as to the excellence of the German product, but in his travels from the North of Sweden down to Italy he, personally, had not come across moulders of the calibre of the Scotch and English moulders, and considered that the castings produced in Great Britain were most excellent. The Continental countries have spent more money on universities and research work than have the people in Britain, and it is on the academic side that our Continental friends have got ahead of us. Sheffield until last year had never had foundry teaching at all, but by establishing a Trades Technical Socioty the first step has been taken towards having a foundry course in the University. Although very little of the research actually done in foundry work during the war can be referred to, there are many excellent papers which should bo studied by all those connected with foundry management.

Loam moulding was tho first type of moulding practice, and the bronze castings made in the very early days would probably be moulded in loam, but undoubtedly tho bronze age in Britain had passed into the iron age about a century before the first Roman invasion. At Wortley the early iron workings of the Danes could be seen, the iron (wrought, not cast-iron) being directly produced from the ore. Tho first cast-iron was made in Sussex, with charcoal as the fuel, but progress was not regular until coke was introduced.

Permanent Moulds.

The preparation of a permanent mould is one of the problems in foundry practice that is before us at the moment. As to whether it is advisable to core by means of dried cores or to make a pattern to leave its own cores is another problem, but there is no doubt that dried cores are very useful for machine moulding.

In choosing a moulding sand one has to consider its composition, texture, bonding powers, porosity, as well as its resistanee to the action of the fluid metal, which action, however, is not always a question of temperature, and is, therefore, a distinct feature for research.

It is always advisable to avoid oxidation when melting alloys or metals for the mould, and in steel founding this can easily be done.

The fluidity of metals is another question for research, and the effect of superheat on their running power. The lecturer then showed two slides giving the range of temperatures in metals.

Another feature following fluidity and open for investigation is that of liquid shrinkage. In many cases contraction leads to warping, and the lecturer suggested that that could often be modified by the use of gates.

Brass Founding.

Especially in brass founding should the metals constituting the charge be weighed accurately, and any volatilisation losses which could not be avoided should be allowed for before charging.

The lecturer showed slides giving the analyses of the various metals used in brass-work, and said that each one should be at least 99.2 per cent. purity.

Lead should be kept as low as possible in zinc, and the metals employed in brass founding should always be tested for their direct value. He said that all tension brasses contain approximately 60 per cent. copper and 40 per cent. zinc, plus a comparatively low percentage of one other element in the ease of manganese-brass, but perhaps two or more in other alloys.

Internal Chill Castings.

The lecturer then showed a slide of black-heart castings, and another slide of which the castings were white in the centre, called by the lecturer white-heart eastings, but he did not know what was the cause of the latter.

He then showed a slide illustrating growth of iron bars, some of which had bends in them. Professor Carpenter, at Manchester University, has done a good deal of work on the growth of cast-iron, but it is capable of much further development, especially in castings which have to meet repeated heating conditions. In this connection it may be mentioned that a network structure can either strengthen the mass or weaken it. In pure iron, both silicon and carbon have the effect of lowering the change point.

DISCUSSION.

The President, in opening the discussion, said that he thought, after hearing Dr. Longmuir's lecture, they all understood why he had been appointed by the B.C.I.R.A. He was glad that Dr. Longmuir had mentioned the Sheffield Trades Technical Society. There were no special classes for foundrymen and boys in Newcastle, and he felt that the local branches of the Institution of British Foundrymen ought to try to do something in that direction in each centre, and not leave it to a trades technical society to do so.

Mr. J. W. Frier referred to the question of the growth of cast-iron, and asked if it had been proved whether a really good iron or an ordinary iron "grew" tho most. He was thinking particularly of castings which came into contact with heat, for example, fire-grates and bars.

Manganese Content and Growth.

Mr. R. O. Paterson said, with regard to the question of the growth of cast iron with superheat, that he believed Professor Carpenter had suggested a high manganese-content to overcome growth, but he would like to know whether the manganese itself has any effect, or whether it is that it gives the carbon a different structure in the casting.

Mr. Cooper said that he would like Dr. Longmuir's opinion as to why a ladle of converter steel should cool more quickly than another ladle of converter steel, both apparently being at the same initial temperature. Also he would like to know Dr. Longmuir's opinion about the foundries on the Continent, and if he had not found that the workers there were given more encouragement than they are in this country.

Mr. C. Gresty asked, with regard to the effect of silicon on the change point of pure iron, whether Dr. Longmuir had carried out similar experiments on ordinary grey cast iron. His experience had been that, as the silicon-content was increased, the carbon change point was raised, not lowered.

Mr. H. J. Young said that the lecturer had stated that silicon lowers the change point of iron, and he would like to ask what would raise it. Also the lecturer had said he did not know the reason for white-heart castings; but did he know the remedy?

Mr. Logan, in a few remarks, said that he had found the question of the high-tension manganese brass very interesting, but in their work they had found it necessary to consider more than the fracture, and not only analysed the metal, but tried to keep the structure within limits.

Mr. Paulin asked if rapid cooling caused a difference in the structure of the iron, and whether Dr. Longmuir had noticed that iron which has been cooled rapidly has a different colour from ordinary iron when machined, and whether there was any particular reason for that.

Regarding the question of white-heart castings, Mr. White said that he had come across the same thing when casting a number of pistons, and had never been able to discover the cause of it, and would be glad if Dr. Longmuir could spend a few minutes on that subject.

Mr. Flack asked, with regard to an ordinary core wheel made of steel with a 0.5 per cent. carbon-content and cast in a green sand mould, why, although the boss was drilled quite easily, the drill would not touch the rim of the wheel.

Mr. Lillie said that he had listened with great interest to Dr. Longmuir's lecture, and he would like to know what the lecturer considered to be a safe arsenical-content for gun-metal work for super-heat steam. Also, did the lecturer consider that 1,173 deg. C. was too high to heat gun-metal? He (Mr. Lillie) had been able to obtain good castings from gun-metal at 1,130 to 1,240 deg. C., giving 16 tons tensile, but, of course, a lot depended upon the type of the casting. Did Dr. Longmuir not think that the tensile properties were reduced during the time that the metal was kept stewing in the furnace? He would also like to know whether the phosphor-bronze mixture was made and then remelted, and whether the test-bars were sand- or chill-cast.

Mr. Wilkinson said the point about the casting temperature had been of great interest to him, and he thought that he had read in Dr. Longmuir's book on foundry practice that the proper casting temperature was when the metal would just run out of the ladle, but he did not quite agree with that, as he considered that some metal just coming out of the ladle was not fit for anything but scrap. Foundrymen are always seeking metal that will set or freeze without contraction, and they want a metal that will stand pressure, but up to the present it has been almost impossible to get one without the use of chills.

THE AUTHOR'S REPLY.

Dr. Longmuir thanked all present for the interest shown in his lecture, and was especially glad that the Chairman had referred to the foundry trades technical classes, as their chief object was to encourage the junior members to take definite courses of evening classes. Before the University can create a course especially for foundrymen, there has to be a demand from foundrymen—a demand from the trade—and he thought that that demand would eventually come, and that, under the guidance of Professor Desch, classes would be formed in Sheffield in the near future. In London there are at least five technical schools where foundry classes are given regularly, and it is remarkable that Sheffield, with all its facilities, had no foundry classes at all. The reading of simple papers is another step towards progress, as this arouses interest in the actual worker, and so feeds the society.

Growth of Cast Iron.

With reference to the growth of cast iron, the lecturer said that it was not altogether a question of whether the iron was good or bad, as suggested by Mr. Frier, but, he believed, Dr. Carpenter had shown that growth was due to the oxidation of the silicon-content in the metal, but he was not certain about that point. He believed that the reason for adding manganese was to neutralise the influence of silicon, but it is a subject, like many others in foundry practice, that one cannot be dogmatic about.

Mr. Cooper had brought forward the question of two ladles of converter steel of the same heat—one cooling more quickly than the other. He could not give the reason for that, unless one of the ladles *was* hotter than the other or both ladles were not of the same composition; otherwise one would expect them to cool at the same rate.

Mr. Gresty had referred to the effect of silicon on the change point of pure iron and the opposite effect on cast iron, but he (the lecturer) had not done any work of that kind on cast iron, though he believed that Professor Turner had done a good deal of work on the subject.

The Chairman had brought up the point that silicon lowered the critical point, and asked what would raise it, but he was afraid that, up to the present, nothing had been done on cast iron in that direction, although a lot of work had been done on steel.

Improvising Standards.

Dr. Longmuir welcomed Mr. Logan's remarks as to the advisability of analyses, and even micro-structures, before tapping the charge. He had mentioned fracture because, in the days when they had not a laboratory, they simply prepared standard chill moulds and cast series of known compositions, had them checked outside, and got a series of standard fractures and compared them with the standards.

The white-heart castings referred to could not be cured except perhaps by keeping the manganese-content high.

As to the core-wheel, he did not know why it should be difficult to drill unless the effect of the green-sand mould had made it hard. Mr. Lillie had spoken about the casting temperature for gun-metal castings, but that depended upon the kind of casting even if poured from the same metal.

With regard to the arsenical-content, he considered that 0.47 per cent. was on the high side, but it was really a question of whether the arsenic would be injurious in large amounts. He had known brass founders to add arsenic to gunmetal to get better results. The phosphor-bronze test pieces he had referred to were made from remelted metal.

He thought that in the book Mr. Wilkinson had referred to it was stated that the correct heat for casting was when the metal would clear the lip of the ladle without leaving any scum. He quite agreed that people are looking for a metal which will give no contraction, and once it is found many troubles will disappear, but after all, there are natural laws in metals as well as in human beings.

Vote of Thanks.

Mr. Wallace then proposed a hearty vote of thanks to Dr. Longmuir. One thing that had impressed him in Dr. Longmuir's lecture was the importance of accuracy of detail. The question of quality of metals reminded him of two ordinary turbine castings made 16 or 17 years ago, when the two halves must have grown, for when they had to be put together they would not meet. There was possibly some difference in the silicon-content of the two castings.

Mr. Smith seconded, and said he thought the reason for everyone having come to hear the lecture was because Dr. Longmuir, with about twelve more, were the founders of the Institution of British Foundrymen. He was sure they were all delighted to have him there, and fully appreciated his lecture.

The Chairman, before putting it to the vote, said that the local Branch of the Institution was doing what it could to educate people, and they were having two more educational Papers that session. They were doing their best to impress upon the Universities the necessity for classes. He noticed that members in the brass, iron and steel trades had all taken part in the discussion, and that it was remarkable that Dr. Longmuir had been able to raise questions from so many sources, and he did not think any other lecturer in that branch had ever succeeded in doing this. The British Cast Iron Research Association wanted members, and yet dozens of foundries were waiting to see what the Association was going to do before they would join. Obviously, the less the membership, the less the work done. He sincerely hoped that the foundries on the North-East Coast would be patriotic and join up as soon as possible. The subscription was rated according to the size of the foundry. With Dr. Longmuir as Director, good work would be done—practical work rather than academic,but, of course, a little of both was essential to success in industry.

Dr. Longmuir, in expressing his thanks for the appreciation shown by those present, said he particularly appreciated the Chairman's kind references to the British Cast Iron Research Association. The Association required tools, and the first tools were members and their subscriptions.

Book Review.

Some Aircraft Steels and Material. By Brigadier-General R. K. Bagnall-Wild, Leslie Aitchison, A. A. Remington, A. J. Rowledge, and W. A. Thain, with an introduction by Dr. W. Ripper. Published by Messrs. Constable & Company, Limited, 100, Orange Street, Leicester Square, W.C.2. Price 16s. net.

The reason for the collaboration of such a large number of authors is because the various sections of the book were originally a course of lectures delivered at Sheffield University, under the joint auspices of that institution and the Royal Aeronautical Society. The work is specially to be recommended to every grade of metallurgist, as the authors had the best of facilities for securing data. The section on aircraft drop forgings by Dr. Aitchison is of particular interest for foundrymen, as it cannot help but impress upon them the inroads which this industry is capable of making on their production. We appeal to Sheffield or other University specialising in metallurgy to complete the subject by dealing similarly with the non-ferrous alloys used in aircraft construction, as they are of equal importance. As Mr. H. J. Rowledge puts it, "It is not too much to say that without aluminium pistons the present degree of engine efficiency could not have been attained." There is not much reference to cast iron, except to state "With cast iron we had reached the point where the piston was limiting further development." Apparently, all that is left to the iron foundry is the manufacture of piston rings. These are covered by Specification No. 2K6, which states that the carbon (presumably combined) is to be between 0.55 and 0.80 per cent.; the silicon, 1.8 per cent.; the manganese, between 0.60 and 1.20 per cent.; sulphur, 0.14 per cent.; and phosphorus, 1.0 per cent. The tensile must reach 14 tons per sq. in. The book runs into some 209 pages, and is well illustrated with 112 explanatory figures and illustrations. The book will form a useful addition to all foundry libraries.

Chart of Iron and Steel Prices.—Messrs. W. Richards & Sons, Limited, of Britannia Foundry, Middlesbrough, have recently published a Chart of Iron and Steel Prices, covering the period from January, 1914, to the present date; there are spaces left for filling in prices up to October, 1923. The chart is to be issued annually, about the beginning of October. A curve is included for the price of iron castings.

Smoke Abatement.

Criticism of the Fuel Research Board.

Ex-Baillie W. B. Smith, who was a member of the Departmental Committee on Smoke Abatement, as a result of the report of which the Smoke Abatement Bill was introduced in the last session of Parliament, read a Paper on this subject before the Royal Society of Arts on November 22. The general theme of the Paper may be said to be that, as the Government had taken such little interest in this problem, and, to all intents and purposes, had ignored the Report of the Departmental Committee, the time had come for dealing with the problem in other directions than by legislation alone. The author appealed to the public generally through the medium of statistics of increasing death-rates during periods of fog, and generally urged the greater use of gas and electricity in industries as well as for domestic purposes. He claimed that the Maclaurin process of low-temperature carbonisation had practically solved the problem of providing a cheap gas, and at the same time a good smokeless fuel, and suggested that the time had come when gas undertakings might now add a new department to their works, which in time would become quite as important and quite as remunerative as their present trade, namely, the supply of gas for heat and power to industries, and smokeless fuel for all purposes. A test made by the Glasgow Gas Department with the Maclaurin process had shown that gas for power purposes ought to be capable of being supplied at 1.2d. per therm, which could be conveyed through special mains, and that it was only by bringing down the price of gas to considerably under 3d. per therm that it would be possible for gas to displace coal for steam raising.

In the course of a discussion, Prof. H. E. Armstrong, F.R.S., said all the Committee had done was to prove there was a smoke nuisance. The thing was to find means for getting over the difficulty. The Committee had only dealt with the matter from the point of view of the gas interests, and had not dealt with it at all from the scientific side. He did not know what was behind the report of the Committee, but it paid a great deal of attention to the work of the Fuel Research Board. It seemed to him, however, that now was the time to inquire into what the Board had accomplished, what it had cost and what its programme had been; whether the programme was of any practical value, and whether it was desirable to continue the Board. The position at the moment was that we had no idea of what the programme of the Fuel Research Board was, or whether it was proceeding on scientific lines. He felt that such an inquiry into the position of the Fuel Research Board was necessary, because he had an idea that it was responsible for a great deal of the slowness of progress in this matter.

Prof. W. A. Bone remarked that the sooner a smokeless fuel could be manufactured and distributed at much the same price as coal the better. That was the direction in which the solution must be sought. He believed, however, that the problem of manufacturing a domestic smokeless fuel was one which did not merely include carbonising coal, and he looked forward to the time when the solid fuel for domestic use would be a much more highly manufactured article than anything that had yet appeared. He believed the time would come when the greater part of the ash would be removed by flotation processes, and that the coal would be carbonised in different ways to get particular textures to obtain a fuel of the requisite degree of combustibility, because the problem was not simply one of smokelessness, but of obtaining a fuel as ashless as possible also, together with the requisite degree of combustibility.

Mr. Justice P. O. Lawrence, on Tuesday, confirmed the resolutions of Vickers, Limited, extending their objects. The objects of the company were extended in 1918 to enable it to use in post-war trade the buildings and plant which it had acquired during the war for national purposes. As a result of these additional powers Vickers, Limited, are, it is pointed out, enabled to fully develop the great resources of the company

The Becco Engineering & Chemical Company, Limited, have recently taken five orders for water softening and purifying plants, including the Gas Light & Coke Company, the Bush Company, Limited, Thos. Whiffen & Sons, Limited, and the Erith Oil Works, Limited. At the latter works, the company are installing a water softening plant of 16,000 gallons per hour capacity, and a heater of 20,000 per hour capacity.

Rubber Equipment in the Foundry.*

Leakage, waste of power and higher operating cost may be traced directly to the use of unsuitable hose and other forms of rubber equipment. The subject may be considered under the following heads:—Hose for vibrators, pneumatic tools, air hoists, sandblast, sandblast barrels, for wetting down the sand, for paint spraying machines, and for acetylene and oxygen. Additionally there are rubber gaskets for sandblast barrels, rubber cloth inserted sheets for lining sandblast chambers, hose for pneumatic sand sifters, and hose for revolving steel brushes.

Compressed air is more costly than the power used to produce it, and therefore its efficient use deserves as much attention as that bestowed on steam, water or electric current. A leak in the air line, or excessive use at a motor will not endanger the operator. In this respect it differs from steam which clouds the view, electric current sometimes responsible for a shock or burn and water which floods the premises. Nevertheless, to save the coal pile, careless and wasteful methods of handling compressed air should be eliminated. To do this several basic features should be kept in mind. Leakage at couplings, or through the hose never should be permitted to exist. They can be prevented by the proper application of gaskets in connection with the couplings and by exercising care in the selection of the hose itself.

Pressure which the hose will stand is inversely proportional to its diameter. A 1-in. 6-ply hose may have a bursting pressure as high as 800 lbs., while a 2-in., 6-ply hose made of the same materials would burst at 650 lbs. Hence care always should be taken to specify greater number of plies for the larger sizes.

Kinking.

To secure good, economical service, air hose must not kink. Kinking not only shuts off the supply of air at the time, but it creates a permanent injury in the wall of the hose, which later develops into a leak. To prevent accidents of this character, the thickness and number of plies must be proportioned to the size of the hose; the rubber must be of good quality and the inner tube, fabric and outer cover must be properly proportioned to each other.

Sometimes customers specify wire winding as a protection against outside wear. The practice is not recommended. It makes the hose heavy and hard to handle. Once bent, the hose is hard to reshape, and a wire covering is more costly than the thick rubber cover recommended as the best protection for the outside of the hose.

A moulded hose is advisable for any length over 50 ft. This type of hose eliminates extra couplings which retard the flow of air and decreases the pressure at the tool. This is an important feature. It has been found that a 15-lb. increase in pressure can make a 37 per cent. difference in the amount of work accomplished by the tool.

Vibrator Hose.

Air hose used in connection with vibrators on moulding machine usually is $\frac{7}{16}$ to $\frac{3}{8}$-in., and should be of the best quality with a good resilient oil proof tube. It also should have a cover of resilient rubber and the walls should be heavy and substantial. This hose is not subjected to external abrasion, but the cover and wall must be heavy enough to absorb the continued bending without kinking or cracking. The outside sometimes is chafed off by scraping the hose over machines.

Pneumatic Tool Hose.

Hose for chipping and other pneumatic tools, also should be the best procurable. It is subjected to the hardest use, dragged over rough castings, run over by trucks and abused in general. The cover should consist of about a $\frac{1}{16}$-in. thickness of tough rubber. Until recently the practice was to use a $\frac{3}{4}$-in. hose wire wound for the line, with a short length of $\frac{1}{2}$-in. hose, not wire wound, on the end and termed the leader. At present the practice almost exclusively is to use a $\frac{1}{2}$-in. hose without wire winding. A good rubber cover will withstand more abrasion than wire. Wire makes the hose heavier and in addition it becomes flattened when a casting drops on it or a truck passes over it, making it necessary to hammer out the kinks. The automobile tyre furnishes a good illustration of this feature. The tread certainly gets its share of abrasion. Tough rubber has been found the best protection against this abrasion. Metal studded tyres have not proved successful. The character of the tube, or lining, of hose used for this purpose is a most important feature. It should be oil proof, high grade and firmly anchored or vulcanised to the fabric. Oil proofing tends to prevent the ends from becoming soggy and soft through the action of the oil and, what is more important, it prevents decomposition of the tube throughout the entire length of the hose. Oil will affect a poor tube seriously and then small particles of rubber become loosened and are carried to the tool preventing proper functioning of the air ports.

Testing New Hose.

In large foundries many feet of air hose are under pressure at one time. Leaks in the hose mean loss of coal and power. It also means a slower functioning of the tools. Leakage may be divided into three classes: leakage of new hose, leakage of hose which has been in service from three to six months and leakage of old or broken hose. The latter is most easily detected and may be remedied at once, but the other two conditions are apt to create more trouble. After a series of exhaustive tests a prominent mining journal concluded that even new hose leaks, although so slightly that the leaks cannot be detected in the usual manner. It was found that new hose which enlarges most in diameter under pressure, leaks most. Therefore it is advisable to instal hose so constructed that the pressure will elongate it but not increase the diameter. This feature is governed on braided or woven hose by the angle of the threads in the braiding.

Hose three to six months old requires the closest watching. Particular attention should be directed to hose apparently in good shape and presenting no cuts or warning breaks. Time after time hose in this condition has been tested by placing it under water and has been found to be full of little pin holes. This species of leak cannot be detected in any other manner. In a foundry where a few thousand feet of this kind of hose are under pressure, the conditions will be reflected definitely in the coal bill.

Air hose for hoists and other pneumatic tools would require the type of hose recommended in the foregoing. In some cases a somewhat cheaper hose might be used, but the practice is not recommended. The fact must be borne in mind that when a good hose and one of inferior quality are carried in stock, men are apt to apply the cheaper hose where the good one is needed. This practice may prove disastrous, but where all air hose is good hose no harm can be done by using it on all appliances and even on the easier jobs it will prove eventually economical.

Sandblast Hose.

One of the paradoxical points about sandblast service is that the softer the tube of the hose, the longer it will wear. The resilient rubber compound resists the abrasive action of the sand which wears away hard substances rapidly. The tube of the hose also must be smooth, because if there is the least roughness at any point, the wearing action will begin there. Flexibility also is important and the wall of the hose must be thick enough to prevent kinking, because the least kink in a sandblast hose means rapid destruction. For economy in this service, hose should be selected which has a thick inner tube of the best rubber and a good thick wall which is at the same time flexible and springy. Sandblast hose should be of a character that will hold the pressure and at the same time resist the abrasion of the sand. Until recently sandblast hose generally was furnished with a $\frac{1}{8}$-in. lining and with 4-ply duck. Later investigation has demonstrated that a 3-ply will hold the pressure in most instances where the hose is from 1 to $1\frac{1}{2}$-in.

* From an article by an anonymous writer in the "Brass World."

inside diameter. On a ¾-in. inside diameter 2-ply will do the work.

Plies in Sandblast Hose.

When the tube or lining is worn through, the plies of duck are useless in resisting the abrasion of the sand, they will give way at once. Therefore what was saved in cutting down the number of plies is utilised in providing a heavier and better lining. Good sandblast hose should have ¼-in. lining for practically all sizes and the plies should be as follows:—¾-in., 2-ply; 1-in., 3-ply; 1¼-in., 3-ply; 1½-in., 3-ply; and 2-in., 4-ply.

The tube is the heart of the hose. It should be pure gum, tough and resilient so that when the sand strikes it the lining will yield. The sand then will rebound. If the tube does not give, but resists the sand it will quickly be worn away just the same as the casting that is being sandblasted. It does not necessarily follow that all soft tubes are good. They are not. They must be soft, yet tough. A cheap rubber can produce a soft tube, but pure gum and zinc are necessary to produce a soft, tough tube. Wherever sandblast hose is subjected to a bend the wear will be most severe at that point, because the tendency of the blast is to go straight. This condition exists generally at the wall connection where the blast enters the hose. At this point the lining often is worn away completely on one side while still intact on the opposite side. The life of the hose may be extended by giving it a quarter turn every few days so that all sides of the lining will be subjected to the blast and thus wear uniformly.

Wetting Down Hose.

Hose employed for wetting down the sand and for other purposes around the foundry generally is used in ½ and ¾-in. sizes. A good garden hose will serve satisfactorily, as it is apt to get burned or damaged in some manner before it is worn out. Large castings made in many foundries are painted by a spraying machine. The paint hose practically is a good air hose but of somewhat lighter construction, which makes it easier to handle with a small paint gun. Both tube and cover should be of good rubber, oil proof and paint proof. This hose usually is used in ¼, 5-16 and ⅜-in. sizes.

Some manufacturers sell a hose with a black cover for connection with oxygen tanks and one with a red cover for the acetylene tank. This hose is a high-grade air hose, but lighter and more flexible for convenience in handling with small burners. The tube or lining should be of the best rubber, as it has a tendency to deteriorate, particularly from the effects of the acetylene. It is supplied in diameters from ¼ to ½-in.

Sandblast barrels require gaskets, square and round, of various sizes. The stock should be a good, medium, soft rubber. The gaskets vary from 1-16 to ¼-in. in thickness. They prevent the dust from coming out of the revolving barrels. The covers are removed frequently and therefore a high-grade rubber is recommended that will not harden quickly and fail to make a tight joint after the cover has been removed a few times.

Sandblast Chamber Linings.

The usual sandblast chamber is a small room enclosed in sheet metal. Castings are loaded on trucks and run into this chamber to be cleaned. During the operation part of the blast strikes the walls and eventually wears holes. To prevent this the walls are draped with rubber sheets about 3 ft. wido, 5 ft. long, and 1/16-in. thick. Originally this rubber sheet was not reinforced, and as a result tho pieces tore long before they were worn out. In recent installations the rubber sheeting is reinforced with a single ply of fabric and probably will last indefinitely. The rubber should bo of good quality and reinforced with light woight duck.

Special connections usually are furnished by the manufacturer of tho machino for tho paint hosc and the oxygen hose. In all cases where couplings are applied at the plant, care should be exercised to seo that these couplings are not forced into tho hose and that thero are no burrs on the end of tho shank. If the shank couplings are treated with a little rubber cement they will go oasily into the hose and stay thero.

Trade with Japan.

A Report on the Commercial, Industrial, and Financial Situation in Japan, covering the period 1921 and up to June 30, 1922, by Sir E. T. F. Crowe, C.M.G. (Commercial Counsellor), and Mr. G. B. Sansom (Acting Commercial Secretary to the British Embassy in Tokyo), has been issued by the Department of Overseas Trade. It points out that from a British point of view the iron and steel business in Japan has been disappointing, as Great Britain is still a long way from recovering her pre-eminent position in that market and the American share is twice as great as hers; but our country has made some gains during the past few months, and in tinplates, for example, business has been better. The principal development during the period with which the report deals has been in black sheets. Very large quantities of these have been imported by the local galvanising works, but the business has been overdone, and the result is that many claims have been lodged on the ground that sheets were rusty. The galvanised sheets have been in great demand by house-owners who have to comply with the new regulations that houses within a certain distance of the railway line must have fireproof roofs.

German iron and steel has reappeared on the market, and as the quotations were extremely low a good deal of uneasiness was caused to competitors. Notwithstanding the various troubles which have occurred in connection with fishery concessions on the Siberian coast the fish canneries have absorbed large quantities of tinplate and this trade is sure to grow. The attempts to manufacture tinplate locally have not proved successful.

There has been no improvement in the position of the various Japanese ironworks, and at present prices it is said that they are unable to work at a profit. The following table gives an indication of the quantities of iron and steel imported:—

	1921.	1922 (Jan.-April).
	Tons.	Tons.
Iron ore	573,500	226,500
Pig-iron	225,300	75,200
Bars, angles, etc.	148,000	67,700
Plates and sheets	223,800	134,000
Galvanised sheets	16,000	8,000
Tinplates	43,000	29,000
Pipes and tubes	31,700	13,000
Galvanised wire	25,000	19,000
Wire nails	17,000	15,000
Rails	56,000	53,000
Scrap	9,000	15,000
Totals	1,368,300	655,400

Under the heading of machinery the most interesting item to be recorded is the placing by the Government railways of an order for 34 electric locomotives with a British firm. The contract was signed in June, 1922, and the delivery date is September, 1923, so that in next year's figures there will be a welcome increase in the British share.

The water-turbine machinery for Japan ordered during the year June, 1921, to June, 1922, amounts to about 400,000 b.h.p., of which 300,000 were ordered from abroad (two-fifths from America and three-fifths from Europe) and 100,000 from Japanese works. Over and above this there is the big Formosan plant for which machinery ordered comprises five units of 33,000 b.h.p. each. The amalgamation of hydro-electric companies is still going on, and it is mainly these large concerns which are now completing their extensive power schemes.

Mr. W. H. Cook, a prominent member of the Institution of British Foundrymen, was the lecturer at last Saturday's meeting of the Manchester Association of Engineers, and dealt at some length with Pattern Plates before an appreciative audience. An excellent discussion followed the lecture, in which Messrs. Oliver Stubbs, Hindle, Key, Clayton, and Simkiss took part.

The New Parliament.

In our last issue we published a few biographical notes concerning some of the earliest members to be returned to the new Parliament. We are pleased to note that the foundry industries are represented on both sides of the House. We append further biographical details :—

Birmingham, Duddeston.—Sir Ernest Vaville Hiley, K.B.E., was Town Clerk of Birmingham and was lent to the National Service Department to be Director-General of National Service under the Rt. Hon. Neville Chamberlain. He afterwards resigned the Town Clerkship to become director and subsequently chairman of the Metropolitan Carriage Wagon & Finance Corporation, Limited, which includes in its subsidiaries the Patent Shaft & Axletree Company, Limited, and the Willingsworth Iron Company, Limited. When the Metropolitan concern amalgamated with Vickers, Limited, he joined the latter board, but has now resigned these directorships.

Birmingham, Yardley.—Mr. A. R. Jephcott, a well-known Birmingham engineer.

Blackburn.—Sir Sydney H. H. Henn, a director of the Horsley Bridge & Engineering Company, Limited.

Bootle.—Major J. Burnie, a director of Bell & Burnie, Limited.

Chelsea.—Lt.-Col. Sir Samuel J. G. Hoare, Bart., C.M.G., is a director of the Birmingham Aluminium Casting (1903) Company, Limited, and deputy-chairman of the Employers' Liability Assurance Corporation, Limited.

Chester, Altrincham.—Major Sir Collingwood G. C. Hamilton, was Controller of Enrolment for National Service in 1916, and Controller of Contract Claims under the Ministry of Munitions in 1918. Later he acted as private secretary to the Secretary of State for War. He is chairman of the Expanded Metal Company, Limited.

Cornwall, Northern.—Sir George Croydon Marks, C.B.E., is a consulting engineer and patent expert, and has written several text-books on engineering and allied subjects. He is a partner in the firm of Marks & Clerk, consulting engineers and patent agents.

Coventry.—Mr. Edward Manville, M.Inst.C.E., is chairman of the Daimler Motor Company, Limited, and deputy chairman of the Birmingham Small Arms Company, Limited. He is an ex-president of the Association of Chambers of Commerce of the United Kingdom, and a vice-president of the Federation British Industries.

Ecclesall.—Sir Samuel Roberts, D.L., is the head of an old Sheffield family, and was Lord Mayor of the city in 1899-1900. He has represented the Ecclesall Division since 1902; he received a knighthood in 1917 and a baronetcy in 1919. At the dissolution he was further made a Privy Councillor. He is a director of Cammell, Laird & Company, Limited, and J. Grayson Lowood & Company, Limited, and chairman of Wright, Bindley & Gell, Limited.

Fulham, East.—Lt.-Col. K. P. Vaughan-Morgan, director and vice-chairman of the Morgan Crucible Company, Limited, of Battersea.

Gateshead.—Mr. J. Brotherton (Lab.) is an engineer by trade, and has been a prominent figure for several years in connection with industrial matters affecting the engineers.

Glasgow, Central.—Mr. A. Bonar Law is the first Premier to sit for Glasgow. He was educated at Glasgow High School, and it was in the city that he founded his reputation as a business man with the firm of Messrs. Wm. Kidston & Sons, and Messrs. Wm. Jacks & Company, both iron merchants.

Glasgow, Hillhead.—Sir Robert Horne has a notable record of public service, but is best known as Chancellor of the Exchequer in the late Government. He is vice-chairman of Baldwins, Limited.

Hackney, Central.—Col. Sir Arthur Levy Lever, Bart., is chairman of the Eyre Smelting Company, Limited, and a life director of Hart & Levy, Limited.

Islington, North.—Maj.-Gen. the Hon. Sir Newton James Moore, K.C.M.G., is a director of the Dominion Steel Company, Limited, and the General Electric Company, Limited.

Lancashire, Mossley.—Mr. Austin Hopkinson is the proprietor of the Delta Engineering Works, Guidebridge, near Manchester.

Leeds, North.—Mr. H. M. Butler is a director and secretary of the Kirkstall Forge, Limited, Kirkstall Forge, near Leeds.

Pontypool.—Mr. T. Griffiths (Lab.), who has represented the division since 1918, was appointed organiser of the British Steel Smelters' Association in 1899, and divisional officer of the Iron and Steel Trades Confederation in 1906.

Smethwick.—Mr. J. E. Davison (Lab.) is an official of the Ironfounders' Society.

Trade Talk.

The Gath Electric Engineering Company, of Halifax, are removing their showrooms from Southgate to Horton Street.

Yorkshire Engine Company, Limited, Meadow Hall Works, Sheffield, have changed their London offices to 15, Caxton House, Westminster, S.W.1.

The Read Engineering Company (London), Limited, have removed their registered offices from 17, Finsbury Street, to 78, Coleman Street, London, E.C.2, and will in future utilise their old premises for warehouse purposes.

G. D. Peters & Company, Limited, and their subsidiary companies—the Consolidated Brake & Engineering Company, Limited, and the British Air Brake Company, Limited—have removed to Caxton House, Tothill Street, Westminster, S.W.1.

As a settlement with the Inland Revenue authorities upon excess profits duty and munitions levy has not yet been reached, the annual accounts of Palmers Shipbuilding & Iron Company, Limited, could not be presented at their late meeting.

The annual dinner of the Industrial League and Council, postponed owing to the General Election, will be held on December 6. The chief guests will be Sir W. J. Noble, Bt., and Mr. J. B. Williams, the new chairman of the Trade Union Congress. Lord Burnham is to preside.

The members of the Institution of Engineers and Shipbuilders in Scotland met in the Rankine Hall, Glasgow, last week, when a paper entitled "The Treatment of Mild Steel" was read by Dr. Walter Rosenhain, and another on "Launching Velocities and Drags," by Professor Percy A. Hillhouse.

Dr. Bengough, the investigator to the Corrosion Research Committee in connection with the Institute of Metals, was present at a meeting of the Sheffield Society of Engineers and Metallurgists, recently, and read a paper entitled "The Function of Colloids in Metallic Corrosion." Mr. T. W. Willis presided.

At a meeting of the North-East Coast Institution of Engineers and Shipbuilders (graduate section), in the Neville Hall, Newcastle, Mr. J. C. Arthur presiding, a paper was read by Mr. L. S. Swinnerton-Dyer (of Sir W. G. Armstrong, Whitworth & Company), on "The Limit of Power of Diesel Engine Cylinders."

Mr. A. T. Thorne and Mr. J. Calderwood, both members of the firm of Swan, Hunter & Wigham-Richardson, Limited, submitted a paper on "Torsional Oscillations with special reference to Marine Reduction Gearing," to the North-East Coast Institution of Engineers and Shipbuilders at Newcastle on October 17.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to R. M. Bennett, 72, Old Hall Street, Liverpool; Dowdeswell & Morgan, 37 and 38, Merchants' Exchange, Bute Docks, Cardiff; Pickett Metal Corporation Société Anonyme, 22, Queen Anne's Gate, London, S.W.1; South-West Africa Company, Limited, 1, London Wall Buildings, London, E.C.2.

The Burntisland Shipbuilding Company, Limited, have secured an order for the building of a steamer for Bristol Channel owners and for the construction of two smaller craft of 1,000 tons each, also to the order of British owners. The Caledonian Shipbuilding & Engineering Company, Limited, have received an order to build two steamers, each of about 6,000 tons, for the Holt Line, Liverpool.

The contracts for the electrification of a section of the Natal railway, involving a total expenditure of nearly £4,500,000, have been secured by the Metropolitan-Vickers Electrical Company, Limited, C. A. Parsons & Company, Limited, Babcock & Wilcox, Limited, British Thomson-Houston Company, Limited, Telegraph Manufacturing Company, and R. Reyrolle & Company, Limited.

The second division of the Edinburgh Court of Session have granted the petition of the Ardrossan Dry Dock and Shipbuilding Company, Limited, incorporated in 1899, and approved of the special resolution of the company by which the share capital of £720,000 (originally only £20,000) was recently reorganised so as to consist of preferred ordinary and deferred ordinary shares, in place of the participating preference, cumulative preference, and ordinary shares.

At a meeting of the North-Western Centre of the Institution of Electrical Engineers, held on November 14, at Manchester, Mr. A. S. Barnard, chairman, delivered his inaugural address. He said the members were concerned with many things, the electrical equipment of ships and railways, the use of electricity in surgery and therapeutics, in agriculture and mining, and in the textile and chemical industries. He hoped that during the session some attention would be given to the important work of electrical engineers in collieries.

IRON AND STEEL MARKETS.

Pig-iron.

With the notable exception of Scotland, all the principal centres of the pig-iron industry evidence signs of returning confidence, largely due, doubtless, to the result of the recent elections indicating the restoration of more stable political conditions in the country, which should go far to establish a revival of trade and solve the urgent problem of unemployment and its evils. The exception quoted above, that of Scottish smelters, may unquestionably be attributed to the cessation in American buying of late, although last week an inquiry was current on the Glasgow market for 10,000 tons of pig for that destination. Unfortunately, export business on this scale has not materialised, buying being again confined to small parcels for prompt delivery, consumers being evidently content for the time being to limit their transactions to hand-to-mouth parcels. In the Midland area, pig-iron business is reported as slowly improving, the heavy-iron founders having some fairly good orders on hand, while the engineering branches are also getting more active. This has given a slight impetus to the demand for foundry iron, with a corresponding improvement in inquiries for forge qualities. Quotations in the South Staffordshire market are consequently steady, but not quite so firm as would appear on the surface, competition being exceptionally keen for any business offering. Better reports are also to hand from Lancashire, where the market for foundry iron is certainly not so restricted, a larger tonnage of No. 3 quality now being delivered in the district. The anticipation of a rise in the price of Derbyshire iron is not now so strong as it was, and it seems probable that makers will be content to continue selling at 82s. 6d. on trucks for No. 3. The price does not leave much profit on the iron, but probably there is a fair return on the whole working of the furnaces when the by-products are taken into consideration. Business in the Cleveland iron market is, at present, quiet, with prices showing an easier tendency, due possibly to the termination of American buying on a large scale, and a decline in export demand generally. There is, however, still an active market for foundry iron for prompt shipment, but makers are already fully sold till next March, and buyers are too cautious to commit themselves further forward, there being a feeling on the other side that American prices will come down. Ordinary Cleveland iron is too high in phosphorus for American users, but if price comparisons continue to be favourable some further sales will probably be made. In the meantime, while it is possible in some cases to shade Cleveland quotations up to 6d. per ton, makers show no disposition to make any further concessions except in the case of No. 4 foundry, which was offered last week at as low as 87s. 6d. Subject to the concessions just mentioned, last week's quotations are maintained as follows:—No. 1 and silicious, 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 87s. 6d.; and No. 4 forge, 85s.

Hematite is a strong market. Demand continues to improve, and another furnace is about to be put in on Tees-side. The better outlook in the local shipbuilding industry should certainly tend to strengthen matters further. The position at the different works varies somewhat, and prices are a little irregular. For East Coast mixed numbers 93s. is a general quotation, but 93s. 6d. is also named, and 94s. is stated to have been atcually paid. No. 1 is at a premium of 6d. to 1s. per ton.

Finished Iron.

Business in this department of the iron trade, although slightly improved in volume, continues quiet, conditions which must be anticipated as likely to remain over the concluding month of the current year. In South Staffordshire movements in the market are again chiefly confined to the bar-iron section, in which inferior qualities of material are subjected to considerable foreign competition, Belgium especially being favoured at the moment by the rate of exchange. Quotations of £7 10s. delivered for this imported material are still mentioned, and British-made nut and bolt iron is reported to have been sold down to £9 10s. in consequence. This latter price is not general, however. Some British makers are off the market at less than £9 15s. There is little change in connection with better quality bars, crown and marked, although recent experience of the volume of demand encourages the hope that an improvement has begun. There is nothing more hopeful in connection with gas strip. It will not sell freely at the price now quoted.

Steel.

Continued improvement can at last be reported in the steel trade position, and is also reflected in a similar way in most of the auxiliary industries. Reports to hand indicates more steel furnaces going into operation, several of the leading firms having recently booked substantial orders in departments that have been idle for months past. Already a substantial tonnage of new orders is being received by the shipyards, among them two Tees yards, one of which, Richardson Duck's, will be kept busy for a year. A new large passenger and cargo steamer for the Ellerman line has been placed with a Hull yard, and a new 20,000-ton steamship for the Orient Steam Navigation Company with John Brown & Company, of Clydebank. The manager of one of the principal manufacturing firms in Sheffield stated recently that substantial orders for locomotives, wagons, carriages and railway materials are now being placed in this country, and some still larger orders are coming forward. This report is further confirmed by a steady buying of ferro-silicon and manganese alloys, which, though at present in moderate quantities, is distinctly on an increasing scale. In the market for semi-products, basic material, which has been improving for some time past, is very active, and a big tonnage is now being produced. Acid steel billets are distinctly reviving after a long period of quietude; in fact, in all classes of steel except high-speed there is a decided improvement. Some additional open-hearth furnaces are being put into operation, and a number of crucible furnaces are now running five days a week. Unfortunately there is rather grave price cutting going on, which makes a proportion of the business in hand absolutely unremunerative. Some improvement has to be noted in the tinplate industry. The fixed minimum is being adhered to, and 3d. more per box is now generally asked, making the current price 19s. 9d. for the standard box. There are one or two makers, however, who are not so well placed, having substantial specifications against speculative purchases to come in, who are offering plates at the 19s. 6d. minimum. Most makers, however, are well booked up for a couple of months, and are receiving specifications fairly freely.

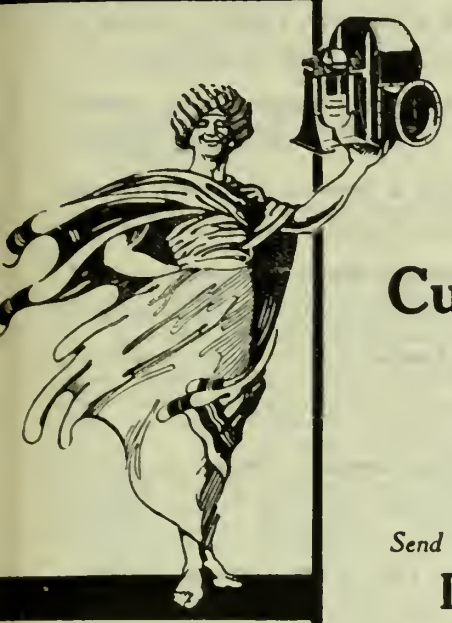
Scrap.

The improvement in demand for heavy steel scrap continues undiminished, and in Scotland is now being quoted at 72s. 6d., although it is stated that more has been paid. Sellers are, as a rule, showing no inclination to commit themselves for delivery ahead at this price, as even now they are finding it impossible to purchase other than odd wagon loads on anything like the foregoing basis. On Clydeside, also, the iron works are now finding difficulty in securing supplies of wrought-iron scrap even for their limited requirements. Holders' stocks have been gradually dwindling down, and unless in the case of a certain class of dismantling job it is practically impossible to get any appreciable quantity of piling scrap. At Middlesbrough business in scrap has been very quiet during the past week. The demand for heavy steel, however, is still quite active for suitable specifications, and the price is unchanged at 68s. per ton delivered works. Other delivered quotations are:—Steel turnings, about 54s.; cast-iron borings, 52s. 6d.; heavy cast-iron machinery scrap in handy pieces, 75s. to 77s. 6d.; heavy wrought-iron bushelling scrap, 55s. to 57s. 6d.; ordinary heavy piling, 60s.; specially selected heavy forge, 70s. to 75s. per ton.

Metals.

Copper.—Conditions in the standard copper market of late have indicated a tendency to lower values, and the fluctuations recorded have been mostly in that direction. Consumptive demand is, however, fairly steady, but buying on home and Continental account continues slow, conditions which may be expected to continue over the remainder of the year. Based on the expectation that copper would to some extent follow the rise in other metals, a certain amount of speculative activity in this market was recently in evidence, but the anticipated rise did not mature. This is mainly due to the fact that the copper market is not affected by such a large number of factors as those that influence tin, lead and spelter. Current quotations:—*Cash*: Wednesday, £62 12s. 6d.; Thursday, £62; Friday, £61 12s. 6d.; Monday, £61 15s.; Tuesday, £61 10s. *Three Months*: Wednesday, £63 12s. 6d.; Thursday, £63; Friday, £62 12s. 6d.; Monday, £62 12s. 6d.; Tuesday, £62 7s. 6d.

Continued on page 456.



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IRON AND STEEL MARKETS,—*Continued.*

Tin.—Following a period of somewhat exceptional activity, the market for standard tin has developed an irregular tendency in values, although fluctuations are still confined within comparatively narrow limits. Some fairly heavy realisations have been effected, and "bears" have seized this opportunity to cover freely, from which it would appear that the technical position of the market has been considerably modified. Sales reported in the East have been on a smaller scale, but at the same time demand on the part of consumers has been somewhat attenuated, the reactionary tendency of the market no doubt restricting purchases. The stocks of tin held in the Federated Malay States are again brought to notice by an official communication from the F.M.S. Government authorities to the effect that the stocks of tin in the hands of the parties to the Bandoeng Conference will not be released until it appears desirable to sell. When tin reaches a certain price, which is not stated, small quantities will be released weekly. If the price falls off again below the point fixed no further tin will be released until prices revive. Current quotations :—*Cash* : Wednesday, £177 10s. ; Thursday, £174 10s. ; Friday, £174 10s. ; Monday, £174 15s. ; Tuesday, £174 12s. 6d. *Three months*: Wednesday, £178 5s. ; Thursday, £175 15s. ; Friday, £175 12s. 6d. ; Monday, £175 15s. ; Tuesday, £175 12s. 6d.

Spelter.—A lower tendency in prices has been marked of late in spelter values, and the recent inflated levels appear to have reacted to a rather substantial extent. The market is still reported firm on the Continent, particularly in Germany. The present high price and the possibility of further supplies being forthcoming from America as a consequence of developing output, together with the tendency for sterling exchange on New York to improve, have been undoubtedly the chief factors in preventing any further appreciable advance. Current quotations :—*Ordinary* : Wednesday, £37 5s. ; Thursday, £36 ; Friday, £36 5s. ; Monday, £37 ; Tuesday, £38 10s.

Lead.—The market for soft foreign pig has been quiet during the current week, the recent buying movement having apparently eased off for the time being. So far, however, the general position is practically unchanged, but the consumptive demand has decreased, and it is considered unlikely that values will be affected to any appreciable extent. Current quotations :—*Soft foreign (prompt)* : Wednesday, £26 12s. 6d. ; Thursday, £26 10s. ; Friday, £26 10s. ; Monday, £26 10s. ; Tuesday, £26 10s.

Gazette.

The "Watt" Electrical Company, Limited, are being wound up voluntarily.

A winding-up order has been made against the British Metal Pressings (1921), Limited, Nile Street, Birmingham.

Mr. G. Saunders (trading as Robt. Saunders), Bay House, Pattingham, and Doctor's Piece, Willenhall, lock manufacturer and brass founder, has been adjudicated bankrupt.

Mr. H. Merrylees, late Sutton Lodge, Great Sutton, near Chester, now The Limes, Marks Tey, engineer, has been adjudicated bankrupt. Exam., C.C., Birkenhead, January 31, at 11.

Messrs. J. Mills and C. Mills, engineers and machine tool makers, Old Farm Works, 34, Angelina Street, Birmingham, trading under the style of J. & C. Mills, have dissolved partnership. Mr. J. Mills continues.

The partnership heretofore subsisting between Messrs. C. H. Walters and F. W. Brownsmith, metal merchants, 14, New Street, Birmingham, trading under the style of Fredk. Brownsmith & Company, has been dissolved.

Trading under the style of Austin Cousins & Company (Messrs. R. W. Cousins and F. C. Austin), Castle Buildings, Swansea, engineers, merchants and commission agents, have dissolved partnership. September 30. Debts by Mr. F. C. Austin.

Trading under the style of the West Don Steel Company (Messrs. T. H. Denton, H. Gee, and W. R. Worrall), West Don Street, Sheffield, steel manufacturers and merchants, have dissolved partnership. November 9. Debts by Messrs. H. Gee and W. R. Worrall, who continue the business.

Messrs. W. H. B. Troman and H. L. Tooth, formerly trading as W. H. B. Troman & Company, 34, Booth Street, Wednesbury, metal merchants, Mr. Troman subsequently trading in the name of the firm and Mr. Tooth in the name of H. & S. Lee & Company, have been adjudicated bankrupts.

A meeting of the unsecured creditors of Thomas and Isaac Bradley, Limited, Capponfield Blast Furnaces, Bilston, in voluntary liquidation, has been convened for the purpose of voting upon the scheme, the terms of which were approved by the members of the committee appointed by the creditors at the meeting held on June 7.

Company News.

Siemens Brothers & Company, Limited.—Interim dividend on ordinary shares passed.

Blyth Shipbuilding & Dry Docks Company, Limited.—Final dividend, 9d. per share, less tax.

Warbrooke Engineering Company, Limited, 139, Cannon Street, London, E.C.—Capital £50,000 in £1 shares. Directors: W. G. Wark, G. Brooke and A. Howarth.

Dorman, Long & Company, Limited.—Dividend on preferred ordinary, 8 per cent. per annum, less tax, for half-year ended September 30 ; no dividend on ordinary shares.

The Broomside Foundry Company (1922), Limited, Broomside Foundry, Camp Road, Motherwell.—Capital £7,000 in £1 shares. Directors: S. Anderson and A. Auld.

William Buckley & Company (Millsands), Limited.—Capital £10,000 in £1 shares. Engineers. Directors: H. W. D. Fielding, Harriet Pagan, J. A. Pagan, and G. S. Rich.

Langdon Engineering Works, Limited, Bond Street, Northam, Southampton.—Capital £15,000 in £1 shares, to take over the business carried on by A. G. Langdon, as the Langdon Engineering Works.

Charles Bell, Limited, the Iron Works, Bath Street, Leeds Road, Bradford.—Capital £15,000 in £1 shares (7,500 5 per cent. cumulative preference and 7,500 ordinary). Engineers. Directors: Lazarus Bell, Leonard Bell, and H. H. Cassé.

Cargo Fleet Iron Company, Limited.—Report for 1921 :—Profits, £138,562; brought forward, £130,635; depreciation, £25,000; debenture interest, £41,351; available, £202,845; dividend, 5 per cent., less tax, £50,000; carry forward, £152,845.

South Durham Steel & Iron Company, Limited.—Accounts for 1921: Profit, £88,566; brought forward, £122,846; debenture interest, £13,500; depreciation, £30,000; dividend, 2s. per share for year, £35,000; carried forward, £114,912. Report for 1922: Profit, £99,651; brought forward, £114,912; total, £214,562; depreciation, £30,000; dividend, 2s. per share for year; carried forward, £118,062.

Romford Engineering Company, Limited, 108, Victoria Street, London, S.W.1.—Capital £5,500 in 5,000 12½ per cent. participating preference shares of £1 each and 10,000 founders' shares of 1s. each, to adopt an agreement with Axioms, Limited, and to carry on the business of manufacturing engineers, etc. Directors: W. Wrentmore, C. E. Ralfs and Engineer-Commander T. H. Greenwood.

Deaths.

Mr. W. Wright, a director of the Burnbank Foundry Company, Limited, of Falkirk, died on November 5, aged 59.

Mr. A. J. Horsey, managing director of the Iron and Marble Company, Limited, 33, Victoria Street, and Thomas Street, Bristol, died recently, aged 69 years.

Mr. D. F. McNaughton, managing director of Glegg & Thomson, Limited, iron and metal merchants, of 255, George Street, Aberdeen, died on November 2.

Mr. J. H. Broomhead, iron, steel and metal merchant, of Norton Street, Ancoats, Manchester, died recently. The business will in future be carried on by his son, Mr. W. C. Broomhead.

Colonel George Kearsley died on November 7, at his residence, Prospect House, Ripon, in his 81st year. The deceased gentleman was for many years a partner in the British Ironworks, which business is now carried on by Kearsley & Company (Engineers), Limited.

Provost Frood, J.P., managing director of the Motherwell Iron & Steel Company, Limited, Motherwell, died on October 27. The deceased gentleman was in 1920 elected first Provost of the amalgamated Burgh of Motherwell and Wishaw, and took an active part in municipal work.

Mr. C. V. Faviell, chairman of John Stewart & Son (1912), Limited, died recently at Teddington. Mr. Faviell, who was the youngest son of the late Mr. W. F. Faviell, of Down Place, near Guildford, was born in Ceylon in 1865, and early in his career took part in the construction of the Manchester Ship Canal. In May, 1891, he joined the firm of John Stewart & Son, Limited, of the Blackwall Iron Works and Canal Dry Docks, Poplar, as a director, being associated in the management of the company for many years with the late Mr. Joseph C. Jobling. He continued as a director until John Stewart & Son (1912), Limited, was formed, when he was elected chairman.

THE

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Contents.

	PAGE
Blowholes	457
Sheffield as the Centre of the Refractories Industry	458
Birmingham Metallurgical Society	458
How Quality is Produced under Quantity Production Conditions	459
Institution of British Foundrymen—	
Cupola Receivers	462
Blow-Holes	463
Blow-Holes: Their Cause and Cure	463
Making a Skin-Dried Clutch Mould	465
Some Casting Problems of Acid-Resisting Irons	466
Working Slags	470
Gating, Feeding and Casting	471
An Apprenticeship Course in Foundry Practice—XXI.	473
"Perfect" Castings	474
Manufacture of Synthetic Cast-Iron in the Electric Furnace	475
London Branch Annual Dinner	475
Paris Congress and Exhibition	475
Trade Talk	475
Iron and Steel Markets	476
Gazette	478
Company News	478
Personal	478

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Blow-Holes.

This week the subject of blow-holes assumes much importance in our columns, as not only is it dealt with under that caption by Messrs. Field and Wilkinson, but also Mr. E. Longden, in his Paper on "Gating, Feeding and Casting," has dealt very thoroughly with the matter. We agree with Mr. Wilkinson that the term should be confined to defects which can be definitely ascribed to gases evolved by the metal, *per se*, or through its reaction with the sand.

We fail to see on what basis Mr. Wilkinson assumes the production of Fe_3O_4—the magnetic oxide. This compound can also be written as $FeO.Fe_2O_3$, and we are of opinion, based on the presence of large quantities of reducing media, that if such a compound was formed it would only be momentarily, and that it is far more likely that any steam present would react as in equation (i):

$$(i)\ Fe + H_2O = FeO + H_2.$$

As is stated, a large portion of the iron consists of Fe_3C, and we put forward equation (ii) as representing the reaction between the ferrous oxide and the carbide.

$$(ii)\ Fe_3C + FeO = 2Fe_2 + CO.$$

To our mind, what happens when the molten iron touches the sand is that primarily the gases rush in front of the iron without reaction, except where they are forced to bubble through it. However, before the gas (steam) meets the iron it has to pass through a stratum of hot carbon in the form of blacking or other dressing. This being so, the steam would be broken up before it reaches the iron, as in equation (iii):—

$$(iii)\ H_2O + C = CO + H_2.$$

Now it is quite conceivable, as has been pointed out by the contributors to the subject, that cupola or any iron may carry ferrous oxide, and the two reducing agents would react with the oxide, reducing it to its metallic condition with the production of carbon dioxide and vapour; these would be reduced again by the carbon and other elements. It will readily be seen that a cycle of reactions may be taking place in rapid succession. Unfortunately, our knowledge of high temperature chemistry is limited, and we are apt to infer that reactions similar to those taking place at a less elevated temperature are maintained. Before leaving Mr. Wilkinson's Paper we would point out that the blue flame found at the joints of moulding boxes can also be attributed to the ignition of carbon monoxide.

We have laid some stress on the importance of the film of carbon on the surface of the sand as preventing the entrance of steam as such into the liquid metal, and some verification of this can be established by the comparison of a subcutaneous blow-hole which has been near to a good blacking facing and one from the proximity of a mould face not so treated. In the former case they will be silvery and in the latter tarnished with temper colours, thus showing signs of oxidation. Another function of this carbon film is to prevent the oxidation of a film of the metal surface to ferrous oxide, because in this state it would form a fusible slag with the silica of the mould, as in equation (iv):—

$$(iv)\ FeO + SiO_2 = FeO.SiO_2.$$

Thus it can be deduced that a casting showing a good skin on the surface next the mould has not passed any considerable quantity of steam through the body of the metal. When high temperature chemistry is better understood it is highly probable that definite equilibria will be established which will set out the necessary factors which will require to be balanced to eliminate these very objectionable blow-holes. Brinell made a very interesting study of blow-holes in Swedish Bessemer ingots, and could so control them as to place them in any position from the centre of the ingot to subcutaneous. Cast iron is, however, so complicated and of a relatively cheap nature as compared with steel that for the present the best practice for the foundryman to follow is to teem his castings with a metal of a temperature varying indirectly with the weight of the casting—high heat for small castings and low for large work.

Sheffield as the Centre of the Refractories Industry.

By F. G. S.

Amongst other important factors which have contributed to make Sheffield the acknowledged centre of the world's trade in the finer steels is the geological fact that it stands as almost the centre of a district producing the raw minerals necessary for the manufacture of refractory materials, in which term are included firebricks and fire-resisting linings of all kinds.

On the West of Sheffield the carboniferous limestone hills of Derbyshire, which, incidentally, contain in their folds and caves, veins of fluorspar, which is used not only in Sheffield and other British steel-producing centres, but in Canada and the United States as a flux of steel, are also rich in certain places in a deposit of siliceous sand, which, when made into bricks, has proved itself of exceptional value to certain departments of local industry, and which is worked at a number of pits near the High Peak Railway in most remote and exposed positions.

As the mountain limestone dips down to the east it is overlain by the massive escarpment of the millstone grit, which makes such bold features in the landscape as the hill at Matlock on which Riber Castle stands. The upper beds contain at Ambergate a thick seam of hard ganister rock, and when these millstone-grit beds dip down in their turn below the lower coal measures the true hard black or Sheffield ganister, with beds of fireclay immediately below it and a short distance above it, outcrops at many points, such as Dore, Totley. Stocksbridge, Deepcar, Oughtibridge, and other places quite near to Sheffield. This ganister is in great demand for the well-known Sheffield silica brick which is made in the Don Valley, and has a reputation for its high quality which covers the whole of the civilised world. The fireclays are mined and manufactured near Sheffield at Stannington, Loxley, Deepcar, Stocksbridge, Chesterfield, and many other points, and are converted into the bricks which, amongst other uses, line the ladles into which Sheffield's monster steel furnaces are emptied; into the fireclays of which the crucibles necessary for the manufacture of the very best and finest steel in the world are composed, and, indeed, into firebricks of all shapes and sizes, which are sent all over the world for lining stopper rods, in ladles, domestic firebacks, sides and cheeks, and a thousand and one other uses for all kinds of metallurgical and manufacturing operations. Out of the better quality of the Sheffield ganister is made the rough paste which forms the lining of the crucible steel furnaces, and a similar paste known as ground ganister, and consisting of a mixture of the lump ganister rock with fireclay, is exported to India, South America, South Africa and even Australia for the lining of foundry cupolas and the patching and repairing of furnaces of every description. There are in Great Britain over three thousand iron foundries, and it is no exaggeration to say that fully two thousand five hundred of these draw their supplies for lining their cupolas from Sheffield and the Sheffield district.

Sheffield's reputation for this particular furnace lining is such that users are almost everywhere agreeable to pay a higher price for it than for any competing material.

Turning to the steel foundries in all parts of the kingdom, their compositions and sands almost all emanate from Sheffield or its near vicinity. Sheffield "compo." has a national reputation, and many a steel foundry in Scotland and the Tyne and Tees district would be in a dilemma if supplies produced or originated in Sheffield were not available.

Going a little further west, and leaving out of consideration the particular coal which is ground up to make a fine coaldust essential in the production of first-class iron castings and the unique furnace coal in demand all over the country for certain metallurgical operations, we pass through the coal measures to the outcrop of the dolomite which runs north and south in a line from Sunderland to Nottingham only a few miles from Sheffield. It is worked and burnt into what is known as "basic," a material absolutely essential for the production of cheap steel by means of the basic process, and also for making the bottoms, or hearths, of basic electric furnaces, of which there are now so many in the City of Sheffield. This local "basic" is sent out to the large steel furnaces throughout the country, the value and importance of this business being hardly perhaps sufficiently recognised. Still within the radius of Sheffield influence, and only a few miles further west, there is the Worksop and Mansfield sands, and what ironfounder, be he making wringing machines in Keighley, malleable castings in the Black Country, or pulleys in Manchester, does not know the name of Mansfield? Worksop sand is almost as well known, and vast quantities of both are despatched every year, a great deal of it through firms operating from Sheffield. By virtue of the knowledge obtained locally, Sheffielders have been responsible for the financing and exploitation of such minerals as those just mentioned in all parts of the country, and indeed the world, and though one could instance numerous other examples of the value of local minerals to the metallurgical, gas, glass and engineering businesses, sufficient has perhaps been said to enable readers to realise that though refractory materials are not so much in the public eye as steel and its products, the business in them is nevertheless of "key" value to the whole world, and the annual turnover not one to be despised when regarded as a contribution to the city's income.

Birmingham Metallurgical Society.

At a meeting of the Birmingham Metallurgical Society, held at the Chamber of Commerce, on Thursday, November 30, Mr. A. R. Page, of the B.S.A. Company, Limited, read a Paper on the subject of high-speed steels, the President (Mr. A. J. G. Smout) being in the chair.

After referring to the highly complex nature of the subject, and briefly outlining the history of high-speed steel, Mr. Page discussed the various theories that had been advanced during the past 20 years in order to explain the properties of these steels, and summed up existing knowledge of the matter.

The important subject of hardening and tempering high-speed steels was dealt with in detail, and attention called to the great care necessary for their successful treatment. It was stated that ideal hardening produced a steel showing under the microscope a small grained polygonal structure possessing an austenitic appearance. The effect of tempering was shown and reference made to the phenomenon of "secondary hardening." The author pointed out that there is very great need for some simple test whereby tools can be checked, in order to be sure the best treatment has been successfully carried out and that the cutting properties of the steel are satisfactory. In this connection file and Brinell hardness tests were often misleading, and bore little or no relationship to the cutting properties.

Mechanical methods of testing were discussed, notably drilling tests and the tool steel testing machine. The Paper was well received, and was followed by an interesting discussion of the whole subject.

Saving Energy in Compressed-Air Plants.—In a recent article in "Glückauf," Herr A. Hinz, of Essen, mentions a new design of compressed-air motor in which the exhaust is effected by means of slotted ports in the cylinder controlled by the piston. The expanded and cooled air escapes on the opposite side of the cylinder to the inlet, and cools the inlet ports. The residual air escapes through a special channel until the period of high compression commences. The residual air is again heated up to a greater extent than it was cooled down, and this due to the higher compression ratio. The freshly compressed air admitted mixes with the warmer residual air, so that, at the commencement of expansion, the temperature is higher than it is in the inlet pipe. In this way the compressed air is preheated, and this diminishes the risk of freezing, besides decreasing the air consumption. The 20-h.p. compressed-air motor in question is now at work, and troubles due to the formation of ice are eliminated, the consumption of air being about 1,230 to 1,400 cub. ft. per h.p.-hour.

How Quality is Produced under Quantity Production Conditions.*

By H. Cole Estep (European Manager of 'The Foundry").

In European eyes "mass production" seems to be the chief characteristic of American industry, with emphasis on the number of articles made rather than their quality. It is only natural, perhaps, when viewing modern manufacturing methods in which a huge volume of production is the most spectacular but by no means the most important feature, for some people to make mental, if not verbal, reservations as to the quality of the goods turned out. A large number of American engineering writers have laid great stress on the speed of present-day methods, at the same time explaining how most of the operations can be entrusted to what is termed "unskilled" labour. In view of this it is not surprising to find in many quarters an impression that the goal of the average manufacturer in the United States is quantity, and quantity only.

What the author hopes to show more or less clearly, especially as applied to the foundry business, is that organisation for a large output is worse than useless unless accompanied by an elaborate, carefully constructed and constantly energised system of checks and control, whereby it is made not probable, but certain, that the article manufactured, be it a casting or a shoelace, will meet certain predetermined standards. It is in these considerations, rather than mere volume, that the philosophy of modern manufacturing is found.

If this philosophy is traced to its source, it is found that the somewhat different conceptions of manufacturing which exist in Great Britain and the United States are due, not to material considerations, but to differences in mental attitude, and if we each can only seek to understand these intangible factors we shall appreciate each other's problems more thoroughly, and thus at one stroke contribute something not only to the progress of engineering but to the comity of nations.

* A Paper read before the West Riding of Yorkshire Branch of the Institution of British Foundrymen.

A Purely British Term.

The term "mass production" is purely British in origin and use. It is seldom heard in American manufacturing circles. People on the other side of the Atlantic prefer to say "quantity production." Superficially, it appears to be another way of saying the same thing, but there is a distinction between the two terms, and one which finds its origin in the slightly different mental attitude of the two peoples toward manufacturing processes; and therefore an exact understanding of these two phrases may help to explain the psychology which has produced them.

In Webster's dictionary "quantity" is not found as a synonym of "mass." "Mass" conveys the idea of a lump, in which the individual particles taken one by one are of no account, and are effective, impressive or useful only in the aggregate or mass. "Quantity," on the other hand, means simply a collection of individual things; it involves the idea of number rather than of bulk, and under this conception the unit is of much more importance.

A Soil-pipe Rigging. The two Cast-iron Patterns are Mounted on a Truck at a Convenient Height for Ramming by Hand. As the Truck Moves Along the Moulds are Placed Across the Rails and are thereby Automatically Levelled.

So perhaps with manufacturing. If a European foundryman is inclined to look on the casting of 2,000 motor-car cylinder sets per day as "mass production," his conception may not be quite the same as that of his American confrère who thinks of it as "quantity production" and knows that each casting must separately pass certain tests before it is acceptable for use, and must in service give 50,000 miles wear before regrinding.

Scientific Control Basis of Quantity Production.

What the writer desires to make clear before outlining details connected directly with the foundry business is that large output alone is only the first and, in some aspects, the least important step in quantity production. In so far as this applies to the American foundry industry, it is found that its problems to-day are concerned

not so much with increasing production as with the perfection of methods of control whereby the castings now being made will meet the most rigid specifications and satisfy the most exacting demands with the same uniformity as the more elementary requirements of interchangeability is fulfilled. Research and control are the two channels through which American manufacturers are striving to reach their true goal, which is the production of quality goods on a quantity basis.

Nor is this a question of ethics, for the adoption of high standards is necessary from business considerations. Under quantity production conditions, the risk involved in turning out an inferior product is far greater than in the case of a small business, on account of the greater momentum of the large factory, if for no other reason. A certain automobile company in the Middle West of America was nearly ruined through turning out an inferior back axle for a single season. Examples of this sort could be multiplied. The necessity for giving constant thought to the kind of goods produced, if quantity manufacturing is to succeed, is made more clear by considering for a moment what modern outputs really mean. To start with a basic commodity such as pig-iron, the American production of this material at the present time is about two and a half million tons per month. In other words, the output of the United States in nine or ten weeks is about the equivalent of that in Great Britain, under existing conditions, in a year.

The Straight Line System of Moulding Cast Iron Car Wheels. The Metal is Carried Along the Lines of Moulds on Overhead Trolleys.

Thousands of Tons per Day.

More spectacular is the production of the automobile industry. The average production of passenger cars so far this year has been 170,000 a month, or at the rate of a little over 2,000,000 cars a year. The lowest output—in January—was 70,000 cars, and the highest—in June—263,000. To this must be added an average of 17,500 trucks per month—5,000 in January and 25,000 in June—making the total production of the country 288,000 vehicles in the latter month. Translated into foundry terms, this output means 11,000 sets of cylinder castings per working day, together with an equal number of flywheels and transmission cases, about 60,000 pistons, and 180,000 piston rings. This means melting and pouring over 3,000 tons of iron a day, and making the moulds into which to pour it.

Impressive as these figures are, they represent only one branch of the American foundry business. Another branch, the cast-iron railway truck wheel foundries, melts over 3,500 tons a day. Equally large is the melt of those foundries connected with the heating, plumbing, steam and gas fitting trades. Amongst the steel foundries there is one group of five shops delivering 2,569,327 castings to their customers in a single year, or about 1,000 a day from each plant. The average weight of each casting was 17.29 lbs. These figures are not presented with the idea of making any comparisons with production elsewhere under totally different conditions, but with the idea of suggesting the dimensions of the problem of control of quality under these circumstances.

Leaving aside the commercial aspects of the problem, it is found that, from the engineering standpoint, quantity production is made possible, first, by so sub-dividing operations that each step is made as simple as possible; secondly, by providing machines wherever possible to take the place of hand labour; and, finally, by devising a system of control and inspection which will ensure the work being turned out to predetermined standards. Of these three steps, the last is perhaps the most important, but the first two have resulted in a complete change in the way the factor of human skill enters into the problem of production. This is a matter of no little moment.

It is customary for those who take the position that modern high-speed production implies a lowering of quality standards to point out that these methods have eliminated the skilled workman and annihilated craftsmanship, without which a superior product cannot be produced. This is not true. What quantity production has done is to change the way in which craftsmanship is applied to the job. In part, under the factory system, the responsibility for quality, which is the most that craftsmanship implies, is transferred to the engineer and the trained executive, while the workman, instead of losing by this shift, is left more free to specialise and to become truly skilled within his particular sphere.

The Sub-division of Labour.

In the foundry, to meet successfully the enormous demands of a twentieth century civilisation, special methods, involving radical departures from regular, traditional, or what might be termed orthodox practices, have had to be developed and introduced. Commenting on this, Pat Dwyer, engineering editor of "The Foundry," stated: "It was realised that the human factor could not be dispensed with altogether, but it was felt that by providing suitable mechanical equipment the out-

put from each operator could be tremendously increased without the slightest deterioration in quality. Furthermore, as the scope of mechanical equipment was extended it was found that the process of making moulds could be divided into many elements, and that each of these elementary operations could be performed by a separate workman. Therefore in the United States, where formerly a period of four years was required to develop a moulder, competent to begin and finish his work, under the system now in vogue in specialty shops, ordinary labourers can be taught in a few hours to fill any missing link in the long chain of production."

This not only illustrates the flexibility of the quantity production system, but also goes to show that while moulding skill, manual dexterity, and mature judgment on the part of the workman are regarded as an important requirement in a jobbing shop, they are neither an asset nor a necessity in a specialty foundry. Power-driven devices, accurate pattern and flask equipment, and mechanical appliances for handling material and making moulds, have reduced the personal element to a minimum, and have placed the manfacture of certain classes of castings on a mechanically automatic basis. And in many cases the superior precision of the machine has actually resulted in both a more uniform and a better product than could possibly be produced by the most skilled moulders and so-called old-time foundrymen.

But the necessity for a comprehensive and intimate knowledge of foundry practice is by no means eliminated under the quantity production system. It is simply transferred from the many to the few. On those who remain the repositories of skill, judgment and knowledge, the burden of responsibility is enormously increased. It is the part of these leaders to synchronise and co-ordinate the efforts of the various operators, and to set high standards and see that they are maintained. But in a large shop a few such men can direct, vitalise, and control a thousand workmen. Under this system the individual workman simply does one part of a job over and over again. Logically, he does it as well, if not better than a man who has to spread himself over many jobs. Under the quantity-production system, each operation is performed by an expert, who soon develops far more skill than the best journeyman moulder who tries to do everything. This tends strongly to an improvement in the quality of the product.

Views of Henry Ford.

Henry Ford, in a recent book, explains this phase of the problem of co-ordinating quality with quantity production in the following language:

"I have heard it said we have taken the skill out of work. We have not. We have put a higher skill into planning, management, and tool building, and the results of this skill are enjoyed by the man who is not skilled, to his great benefit, for it is self-evident that a majority of the people in the world are not mentally, even if they are physically, capable of making a good living.

"We now have two general principles in all operations that a man shall never have to take more than one step if it can be avoided, and that no man need ever stoop over, in the foundry or elsewhere. Furthermore, a man must not be hurried in his work—he must have every second necessary, but not a single unnecessary one. The results of these methods are visible everywhere in the Ford factories. Take the case of assembling the flywheel magneto. One workman doing the complete used to turn out 35 to 40 pieces in a 9-hour day, or about 15 minutes to an assembly. What he did alone was then spread into 29 operations. This cut down the assembly to 13 minutes. Then we raised the height of the bench at which the men work by 8 in. and cut down the time to 7 minutes. So to-day one man can do what two did."

In the United States it is felt that it is not necessary to follow slow, expensive, hand-production methods to produce a quality product. Given raw materials of the proper sort, coupled with methods which are right and an organisation which ensures the proper maintenance of standards both as regards raw materials and methods, and the result must be a satisfactory product of uniformly high quality. It is firmly believed that this is true, but it is worth repeating that underlying this whole problem is the question not of energising, but controlling, the processes of production.

(To be continued.)

The Metallurgist Watches the Pouring of the Test-piece to Determine the Approximate Temperature of the Metal.

New Zealand Iron Industry.—The Onakaka Iron & Steel Company has had a trial run of their blast-furnace to treat the Golden Bay deposit of iron ore. The result is declared to have been satisfactory and the Company is proceeding to erect coke ovens. Conditions are favourable, for iron ore, coal, and limestone are all near at hand and the deposits are owned by the Company.

Institution of British Foundrymen.

BIRMINGHAM BRANCH.

At the meeting held at the Municipal Technical School, Birmingham, on November 11, there was an open discussion on Cupola Receivers and Blow Holes. Mr. W. J. Flavell (Branch-President) was in the chair.

CUPOLA RECEIVERS.

Opening the discussion on cupola receivers, Mr. F. J. Cook said that anyone who inquired into the question of receivers could not help but be struck by the want of data, both in proceedings of Associations and in text-books. The Proceedings of the Institution, which dealt primarily with foundry matters, he believed contained the word "receiver" only once, and then it referred to a cupola receiver, but in a very casual way. Further, although every foundryman knew what a receiver was, generally speaking there were not many who were acquainted with the fundamental features of receivers. There was, of course, the mechanical operation of the receivers, and also the chemical reactions that took place. Mr. Cook then showed a number of lantern slides illustrating different types of receivers. The first was a well-known outside receiver, which had been made by Messrs. Thwaites Brothers for a very long time. One of the principal arguments in favour of receivers was that there was a considerable saving of coke. In addition, as soon as the metal melted, it dropped away from the coke, and was not contaminated with sulphur to the same extent. Another slide showed a receiver in the body of the cupola itself. The receiver was divided from the cupola proper by means of a brick. One of the detrimental features of the receiver was the question of cold metal at the start. In this particular receiver the gases and flame went right down on to the top of the metal, and it was a distinct improvement, as it gave hot iron at the start. This could not be relied upon where the flame and gases entered at right-angles and struck first the side of the receiver. In two instances, one of which was such a cupola, but the designer did not install a pipe, as he failed to see its use. He said the cupola did very well, but it did not come up to his expectations. In the case of another cupola of this type, a proper side pipe was provided, but unfortunately the cupola man did not see the use of it, and bricked up the hole leading to it. When this was opened out, he found a very great difference in the temperature of the metal. If there was no outlet for the gases in the receiver, obviously there was pressure which retarded the flame coming down.

Dump-Treating Machines.

Some years ago he installed a machine for taking the shot and iron from the dump. Several foundries were visited and details obtained of its efficiency, and in many cases it appeared a paying proposition. When the machine was installed, a careful account was taken of the amount of metal recovered and the time taken in the process, and he found that it did not even pay for the requisite motive power. He came to the conclusion that if the slag was drawn off in a fairly fluid state, the metal ran through the slag and became a cake at the bottom, whereas if they dumped the whole, the slag was very often not so fluid as in the receiver at the end of the blow, and they did not get that settling down of the metal which they did with a receiver. When the iron was recovered in a very fine shot form and recharged into the cupola, it very often went right through the melting zone quickly without being melted, and was found as pellets in the metal. A slide was shown illustrating an ingenious arrangement, designed by Mr. J. E. Hurst, of Kilmarnock, incorporating an oil-fired receiver. This was an arrangement which seemed to him to lend itself to great possibilities. It eliminated the possibility of cold metal at the start, because the oil burners heated up the receiver to quite a high temperature before starting. The metal was tapped out in the usual way, and it need not be tapped out as it was cast. It also lent itself to the addition of different alloys, even of steel. At the present time it was acid lined, but next time it was hoped to replace by basic lining to ascertain the effect on the sulphur. The question of cost with this particular apparatus did not seem to be particularly great. The consumption of oil for the starting period was 15 gallons, and melting for five hours, 31 gallons; total, 46 gallons. That was a consumption of 2.56 gallons per ton of metal. Obviously with receivers mentioned, the saving in coke was not to be obtained with cupolas working on light castings, such as was used in the Black Country, where the tap hole remained open for the whole of the blow.

Summary.

The question of the advantages and disadvantages of receivers he considered might be summed up as follows:—The advantages were that the metal was removed from the coke as melted. It was not contaminated by lying in the coke, particularly if the coke was sulphury. Instead of the metal lying between the spaces of the coke, it all came out into the receiver, and the metal was poured over two spouts, which gave better mixing than just dropping in between the spaces and drawing out with one tap, and, being clear of coke, allowed the metal to free itself of slag better. It also permitted a better chance of freeing itself from manganese sulphide, being kept very hot by the flames playing on top of it. There was, of course, the saving of bed coke, which was quite an appreciable factor. Against those advantages they had the disadvantage of cold metal, due to the warming up of the receiver, and in that respect he thought a receiver inside the cupola was the most advantageous, in addition to which, there was the extra labour in connection with the fettling and looking after the receiver.

DISCUSSION.

Professor T. Turner thought there was no doubt as to the advantage of a receiver, provided they were dealing with a fairly considerable quantity of metal and that they had time to allow the metal to remain in the receiver. Where it could be used, it gave much greater uniformity of metal, a cleaner metal, and a metal that was lower in sulphur. As to fuel consumption, he would have anticipated that it would have been a little higher. Supposing they had continuous melting, and in one case they conducted it entirely in the cupola, and in the other they had to heat up a receiver, he should assume that there would be certain heat lost, due to heat radiation, when a receiver was employed, owing to the larger space which had to be heated. Where a bed of coke could be saved, the economy might be in the other direction.

Mr. Cook said he believed that the cupola without a receiver used to consume approximately 14 cwt. of fuel for the bed, whereas with the Matchell receiver it only required about 4 cwt. It must be remembered that there was not continuous working at the present time.

Syphon Brick Cupolas.

Mr. A. Parsons inquired how it was, in the case of M. Ronceray's cupola, that the moment the blast was shut off the metal stopped running. He suggested as a possible explanation that the cupola, being full of air somewhat under pressure, it naturally pressed down on the metal while the blast was on, and the moment they took off the blast that pressure was released.

Replying, Mr. Cook said it was not the heat from the incandescent coke which caused melting; it was the formation of gases, causing chemical action to take place. If the blast was shut off, the gases which caused the metal to melt were also excluded. Pressure would, of course, also help the flow of metal.

Mr. A. Wardle mentioned that when engaged in melting hematite iron continuously, he very soon discovered that the connecting brick between the cupola and the receiver would not withstand it. The cupola would run possibly for six or seven hours and then the cupola necks became hot necessitating cooling with hose pipes. Much money was spent in attempting to make it a success, but eventually it was concluded that it was merely whipping a dead horse. The receiver which con-

verted it into a successful cupola was removed. Later he was connected with the installing of another receiver cupola, for a different proposition which required a very high temperature. This, too, was an absolute failure, as the first 10 cwt. of iron was useless, being intended for high-class automobile work. During the war when making aeroplane cylinders, the required standard was reached by means of the ordinary cupola.

Mr. Cook said he agreed with what Mr. Wardle had pointed out. With a receiver having the hot air and flame entering at right angles, and not playing on the top of the metal, the same results could not be expected as where it came down directly on to the metal. The connecting brick was a difficulty, but it was sometimes through want of care. With a receiver inside the cupola he had had to make cylinders equally as important as those mentioned, and there was no difficulty whatever in working with an inside receiver. He should not recommend an outside receiver for automobile work. But after about ten years' experience with an inside receiver, he would have no objection to installing one as the metal was always good.

Small Receivers Useless.

Mr. D. Wilkinson said he had had experience with receivers in connection with both large and small cupolas. At one foundry there was a cupola that could melt up to 10 tons an hour and a receiver of 6 or 7 tons capacity. There was a quantity of really heavy work there which required fairly cool metal, and no trouble whatever was experienced with the receiver, but a small cupola with an outside receiver was a failure. On a small cupola, where hot metal was essential, there was no coke saving. The only way in which he had been able to work a small cupola with an outside receiver was by filling the receiver with coke and fitting a tuyere at the bottom. It seemed to him that the siphon brick was quite an unnecessary addition to the cupola, and was more likely to cause trouble than benefit. The way in which he had obtained hot metal from a cupola having a deep well was by inserting a kindling tuyere. This warmed the lower part of the furnace so effectively that really hot metal came down initially.

Mr. Wright said Mr. Wilkinson confirmed his own experience to the advantage of a kindling tuyere. He had used such a tuyere in the cupola for quite a long time, and had found it helpful in getting the cupola started quickly, as it provided a bed so hot that the iron that came down first was not cooled by falling into only partly incandescent coke. He asked whether it was a reasonable suggestion to have a movable receiver so that the small charges could be topped out into shanks and into the receiver used for larger quantities.

Mr. Cook said there were a considerable number of Matchell receivers installed, and they were invariably well spoken of. A movable receiver could be used, of course, but he could not see any reason for removing it.

Mr. Wilkinson read Mr. A. Field's paper on "Blow Holes."

BLOW HOLES.

In dealing with the problem of blow-holes in so far as they may be caused by the metal, particular attention should be paid to casting as hot as possible. Some foundrymen advocate the practice of allowing the metal to stand in the shank for a long time "to allow the gases to escape," and they then cast with metal not far removed from the pasty stage. The author advocates casting as hot as possible, and using a facing sand which will withstand the temperature, then the liability to blow-holes is much reduced. When so doing, there is opportunity for the gases to find their way to the feeding heads, risers or vents, and hence away from the casting; but in cold-cast metal, especially if low in phosphorus and silicon, no such opportunity is provided. If cold metal is sufficiently good for making castings, it is preferable to economise coke and not trouble to melt hot.

In using coke of unusually high sulphur-content, or with metal which from other causes contains a high percentage of sulphur, extreme difficulty is found in making sound, clean castings. Not all blow-holes are due to sulphur, but some undoubtedly are. Such metal, although apparently melted hot, quickly becomes sluggish, and leads to these faults. It is not uncommon in such cases to find a distinct smell of sulphur dioxide arising from the iron in the ladle, a conclusive proof that gases are being evolved.

A further cause of "gassy metal" is rusty or otherwise heavily-oxidised material. An extreme case is seen in the production of annealing pans where 50 per cent. of the cupola charge is old material, with a heavy layer of oxide. Of course, in theory, the whole of this oxide passes into the slag, but in practice there is a tremendous amount of carbon monoxide evolved by reaction within the cupola, and the slag being very heavy and thick, there is no proper chance for gases to escape. Hence one rarely, if ever, sees a reasonably sound annealing-can, and many cans have their life much shortened by their unsoundness.

Damp Ladles.

But to the author's mind, the bulk of difficulties arising from gases are due *not to the metal, but to the mould*. Perhaps as an intermediate step it should be mentioned that the ladle which conveys the iron and from which, not infrequently, masses of bubbles are seen to arise. Damp ladles, especially common with smaller sizes, lead to the evolution of steam, the volume being immense in proportion to the moisture from which it arises. This does not obtain often with large ladles where great risk is entailed by dampness, but with small ladles it is often observed.

Mould Troubles.

From the mould itself, as is well known, large masses of gas are evolved, whether from cores, green sand or dry sand. It must not be overlooked that at a red heat, both core sand and dry sand give off combined water in the form of steam; this, in addition to the steam from the water, constituting the ordinary "dampness" of the green sand. Venting is usually provided but adequate assistance is often not given for gases to escape from awkward or re-entrant corners, dead ends and the like, that it is often here that blow-holes are found. Many such cases have been dealt with, and often it is found that so-called "draws" are, in fact, blow-holes in these awkward corners which have not been sufficiently vented and form a trap or *cul-de-sac* for the gas.

Awkward Places and Hand Ramming.

Such conditions in awkward places are often aggravated by an usually hard ramming in order to make the projecting piece of sand sufficiently tough for it to adhere to the mould, and not to break away in drawing the pattern or otherwise handling the box. This hard ramming makes it still more difficult for the trapped gases to escape when actually the sand there ought to be more open to give facility for venting. Nails or chaplets used on such parts must also be tinned to prevent rust, as this also is a very frequent cause of blowing.

No attempt here has been made to go deeply into the subject or to touch theory, but only to sketch a few of the causes which have come to the author's notice.

Mr. D. Wilkinson then read his own contribution, entitled "Blowholes: Their Cause and Cure."

BLOWHOLES: Their Cause and Cure.

In the machine shop the term "blow-hole" is applied to quite a number of defects in castings. Sandholes are frequently called blow-holes, especially if the sand is embedded in the casting and is only revealed by machinery. A draw or shrinkage hole is seldom spoken of by its correct name. A fragment of enclosed slag or a bubble of trapped air are both liable to be included in the comprehensive term "blow-hole." To be quite accurate, the term should be restricted to defects caused by gases liberated either from the mould or the molten metal. One of the first essentials in the cure of any fault is a correct knowledge of its cause; so to describe as a blow-hole a fault of a totally different nature does not assist in its amelioration.

Common Causes.

Confining the subject to faults due to gases liberated either by the mould or by the metal, some causes of blow-holes need only to be mention to be dismissed. The use of overdamp sand, ramming too hard, and insufficient venting will all cause blow-holes, but in each case the remedy is obvious.

Sulphur and Blowholes.

Sulphur is frequently condemned as a prolific source of blow-holes. While not in any degree designating sulphur as a friend, the author fails to understand some of the attacks made upon it. Malleable cast iron regularly contains up to 0.4 or 0.45 per cent. sulphur, and in a somewhat lengthy experience with this material no predisposition to blow-holes has been noticed by the author. They are by no means unknown, but they could never be traced directly to the sulphur-content of the iron. Certain it is that large quantities of good, sound malleable iron contain sulphur beyond 0.4 per cent. The author is aware that he is by no means alone in the somewhat disconcerting experience of finding the sulphur-content of a cast of automobile cylinders has reached about 0.15 per cent. when, according to usual practice, it should have been under 0.07 per cent. Almost invariably it is found that castings containing this amount are as free from blow-holes as if the sulphur were normal. Experience has shown that the evil effects of sulphur are found in directions other than in the formation of blow-holes.

Dampness and Blowholes.

When a mould is being cast there is an immediate reaction between the steam, formed from the moisture in the mould, and the iron as in (i):—

$$\text{(i).}\quad 3Fe + 4H_2O = Fe_3O_4 + 4H_2.$$

The hydrogen burns at the vents and joints, forming the well-known blue flames. This reaction is endothermic, and abstracts a considerable amount of heat from the metal. The oxide formed occasionally floats on the surface, and on machining is revealed as a dirty patch on the casting. By the time the mould has filled a fair proportion of oxide will have been formed from the decomposition of the water vapour. Usually secondary reactions reduce this oxide almost as rapidly as it is formed. The reactions possible are rather complex, but to simplify matters only one will be considered. A large proportion of the molten metal is composed of carbide of iron, and this material reacts with the oxide as in (ii):—

$$\text{(ii).}\quad 4Fe_3C + Fe_3O_4 = 15Fe + 4CO.$$

To carry out this reaction completely a large amount of heat is required, so a position is reached that unless the metal is sufficiently hot to supply rapidly a considerable amount of heat, a quantity of oxide actually formed within the casting itself remains undecomposed, and floats to the top where it may be revealed on machining. If, on the other hand, the metal is sufficiently hot to supply the heat necessary for the second reaction, there is a quantity of carbon monoxide gas generated within the casting before it has set.

The case of a mould just filled with molten metal having a sufficiently high superheat to remain entirely fluid for some little time after filling the mould, the reaction between the carbide and oxide of iron will be completed, and the liberated carbon monoxide will bubble up to the surface and escape through the sand. The reaction will be completed the more rapidly, and the gas will escape the more freely on account of the high superheat. But if the metal has not a sufficient degree of superheat, a skin of frozen iron will form next to the moist, cool sand of the mould, before the reaction, slowed down by the lower degree of heat, has been completed; and the bubbles of gas, unable to pierce this skin, will remain underneath, to be revealed on machining.

As the two reactions given above take place in every mould containing moisture and molten iron, it follows that the hotter the iron is the fewer the blowholes resulting from the liberated gas, since the additional heat available speeds up the second reaction and slows down the formation of a skin of frozen metal, so allowing the gas bubbles to escape. From this line of argument it can readily be seen how imperfect melting, resulting in oxidised iron, will greatly increase trouble from blowholes by the increased amount of oxide available for reaction with the carbide, and the formation of carbon-monoxide gas. Hence blowholes due to defective melting.

Superheat Important.

According to the superheat of the metal, a casting may thus be obtained entirely free from blow-holes resulting from oxide reduction, or one which, owing to the formation of a frozen skin before the reaction is completed, contains blowholes, or one which, owing to insufficient superheat completely to reduce the oxide, will contain both blowholes and oxide, forming a dirty patch in the casting.

As regards the question of blowholes resulting from occluded gases, the same line of argument applies. If the metal is cast with a fair degree of superheat, the uniform cooling and freezing permits the gases discharged from solution to escape with the gases resulting from oxide reduction. The gases retained by the iron when completely frozen, obviously do not enter into the argument, as whatever state in which they may be retained, they certainly are not retained in the completely-free state necessary to form blowholes.

The cure for blowholes may be stated thus:—Clean, hot, non-oxidising melting, and casting at a temperature sufficiently high to permit the second reaction to be completed before a skin forms and retains the carbon-monoxide gas bubbles.

DISCUSSION.

Mr. J. B. Johnson agreed with Mr. Wilkinson that if they wished to eliminate blowholes, the higher the temperature of the metal, the better. It gave a chance for the gases to escape, and his experience was that castings were very much cleaner and better the hotter they were cast.

Mr. Cook said one had to remember that hot metal would not hold occluded gases to the same extent as cold metal, and therefore it became a question of the time the metal would remain fluid. He could not quite agree with Mr. Wilkinson in saying that he did not look upon sulphur as being the friend of the foundryman. There were certain classes of work where sulphur was a very good friend to the engineer, who had to use the castings. One of the causes of badly-melted iron was trying to save coke. If they had the bed of coke too low in the cupola, oxidation would take place.

Mr. Wright thought the first reaction mentioned by Mr. Wilkinson accounted for some of the explosions sometimes experienced in the foundry floor. Both reactions, however, seemed to affect only the surface of the casting. Does Mr. Wilkinson suggest that blowholes in the body of the metal are caused in this way?

Mr. Wilkinson agreed that the first reaction frequently accounted for explosions resulting from faulty ignition of the gases. The only risk of blowholes being retained from the second reaction was when a skin of metal formed before it took place. If the whole of the metal in the mould was perfectly fluid, and no skin had formed on the outside before the second reaction was completed, the gases had a chance of escape.

Pin Holes in Chilled Rolls.

Mr. A. Parsons said his business was making chilled rolls, and under the skin of the metal pinholes were often found. He would like to have an explanation of that, and he would also like to know the effect of rusty scrap on the mixture.

Mr. Wilkinson replied that, in his opinion, the occurrence of pinholes was entirely due to the second reaction. The use of rusty scrap has the tendency to give over-oxidised iron. If oxide of iron was present in the cupola, some of it would be reduced by the carbon, but it would not all be reduced, as the length of time in which it was in contact with the carbon was not sufficient. It was the inability of the carbon monoxide to escape from the casting, due to the quick setting of the metal, which caused blowholes. The only way in which Mr. Parsons would be able to overcome his difficulty would be to prevent the chill freezing the metal the moment it touched it. This, of course, was not possible.

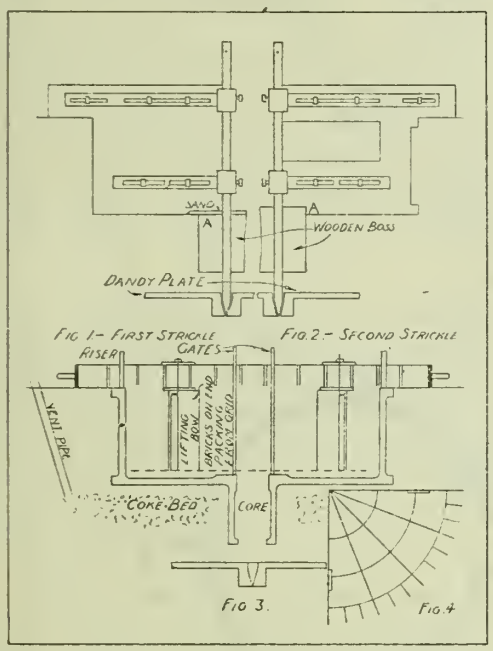
Mr. H. L. Reason (President of the Institution) said it was clear from the discussion that if they were to get to the root of their troubles and

master their business they would have to enter into the question of chemical composition, not only of metal in its solid state, but also in its fluid state. He made a strong appeal to the members to undertake propaganda work, with the view of increasing the membership. It was up to all of them, he said, to take advantage of the information that was available, and make use of it in their everyday practice. They were doing serious national work, and if British foundries were to take their place as the foremost among the industrial nations of the world, they must assimilate the information and experience that was disseminated at the meetings. He thought their cordial thanks were due to those who had favoured them with such interesting contributions.

Making a Skin-Dried Clutch Mould.

By A. Sutcliffe, M.I.Brit.F.

It is usual to make small friction clutches in green-sand moulds from a full pattern. Larger ones are generally made in loam, but such a method is expensive, when only one or two are required. Loam moulding involves four plates, a 2½-in. bottom plate, two circular bending rings, and a 2½-in. top plate. Thus the weight of metal would be about 7 tons for a 7-ft. dia. job in plates alone. In the method proposed the grid for lifting the centre is made in skin-dried sand, which eliminates the above cost. The cost of the mould which will be described will not greatly exceed the cost of moulding the plates and melting the necessary metal when loam-moulding. Even when the tackle is made for loam moulding there is obviously the actual moulding which is expensive, as a loam



moulder requires a labourer constantly. Drying loam moulds is much more expensive than skin drying.

Skin-Dried Method Outlined.

At the pattern-making end of the business, the strickles required are practically the same in the new method as in loam moulding. It incorporates a round bush for the centre, which will fit on to the spindle and produce the part marked "A" in Fig. 1. This would also be advantageous in loam moulding. To commence moulding, a hole is dug of 4 in. less in diameter than the finished casting. It extends to 8 in. below the bottom of the centre boss ("A," Fig. 1). A dandy plate is placed centrally in the hole, and the spindle is set up, ascertaining that the socket is clean.

A cinder bed, 4 in. thick, is now prepared, and a rut is cut in the wall for the vent pipes, as shown in Fig. 4. Some moulders place a ½-in. layer of hay on the cinder bed and sprinkle it with water. The writer fails to see the advantage of this, especially in the case cited, as the bed is only about 4 in. from some parts of the face of the casting. It is, further, difficult to dry the hay by means of skin drying. The hole is now filled in with floor sand up to the boss pattern, and it is well rammed. The boss can now be bedded in and lined up with facing sand, filling in again with floor sand to the top of the boss, which must stand up to the top of the casting plate. This provides a foundation for strickling, as the depth and impression of the top box is given as is shown in Fig. 3. The whole is now rammed up to just above the depth of the strickle, but 2 in. requires cutting down from the sides, which are formed by the ordinary floor of the foundry. This is obviously very solid, and forms a good background to ram up against, and allows of a good top impression being formed.

The first strickle being finished with, the sides are lined up with wet parting-sand, and having made the grid for lifting the centre (Fig. 4), the spindle is removed and cotton waste is placed in the socket to prevent it from being filled with sand, as it is required later in the process. The mould can now be rammed up to the floor joint, taking care to place scotches from the grid to meet the box bars by the lifting bows, thus preventing the grid from slipping. The top box is placed in position, three runners are provided on the boss, and one at each side of the rim for risks. After ramming up the top part, it is taken off and turned over, as is illustrated in Fig. 3. After mending and ascertaining that the gates and risers are clear, the mould is wet-blacked and stoved overnight.

Returning to the bottom portion of the mould, the cotton waste is removed, and the spindle again replaced. The sand forming the base of the mould is cut up to about 4 in. below the top of the boss. Ample venting is given this face with a ½-in. wire cross handle. Some moulders make up these holes one at a time with an iron rod or their finger. The writer, however, does not consider this to be an advisable method, but merely waste of time. It is preferable to scratch them with the fingers and place on facing sand, and then tread with the feet or lightly ram with a flat rammer.

The second strickle is cut to allow for the thickness of the plate, as is shown in Fig. 2. At the boss corner this comes to the top of the plate. The strickle will take from the sides and the bottom the thickness of metal required. The bottom of the face is needle-wired, so as to catch the ½-in. wire-vents below. It is preferable to keep the needle wire on the slant, which allows of the inclusion of many of the ½-in. vents. The centre boss is now removed, and the mould is spindle finished and wet-blacked. The mould is now skin-dried. If coke baskets have been used, clean out the ashes and insert the centre core. Parting sand is placed round the top joint to prevent a crush at the rim edge.

If the method described has been faithfully followed it should be unnecessary to try the thickness with clays. The mould is finished by making up the gates and risers, placing on an adequate quantity of weights, and cleaning the vent pipes. The mould is then ready for casting, and is shown in Fig. 3. Careful examination of the process will reveal it to be much cheaper than when made in loam.

Study of Hearth Gases from Blast Furnaces.—In the course of a study of hearth gases from blast furnaces, being made by G. St. J. Perrott, of the U.S. Bureau of Mines, at Birmingham, Alabama, the results of sampling hearth gases have so far shown no difference in the combustibility of different cokes in the hearth of four blast furnaces. There is a difference in the rate of reaction of different kinds of coke with carbon dioxide at 1,000 deg. C. These results corroborate the combustion experiments that are being carried on in the Kreisinger furnace. The suggestion has been offered that combustibility tests be made in a small furnace at the lowest possible rate at which combustion may be maintained in order to determine if there is a different influence of the various kinds of coke on the rate of combustion at low temperatures. It may be that combustibility of coke in the blast furnace is significant not at the hearth, but well up in the furnace, where the temperatures are much lower. This problem will have to be attacked by getting gas samples higher up in the furnace. It is hoped to make an arrangement with a blast-furnace plant to take samples higher up on the bosh.

Some Casting Problems of Acid-Resisting Irons *

By John Longden, A.M.I.Brit.F.

Several well-known acid-resisting iron-silicon alloys are to-day made into castings, being recognised under such names as Duriron, Ironac, Tantiron, etc., and are especially intended for the use of manufacturing chemists.

These alloys, however, offer exceptional difficulties to the foundryman. The foundry practice which will be described here is that which is carried on in the production of castings in a high-silicon iron having a world-wide reputation. It is not thought desirable, however, that reference should be made to its trade name.

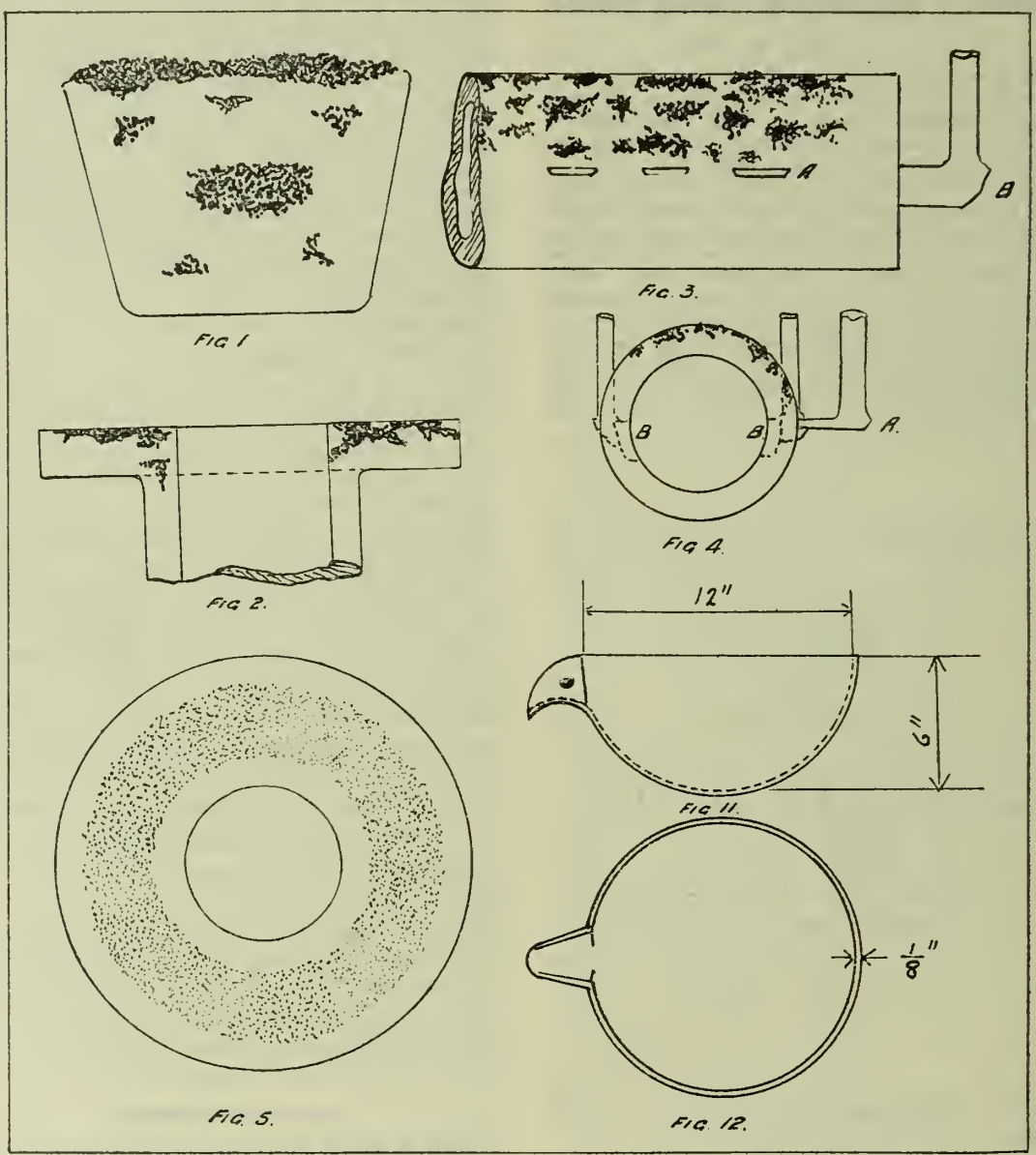


Fig 1 Fig. 3. Fig 4. Fig 2. Fig 11. Fig. 5. Fig. 12.

Composition of the Alloy.

The silicon content of the alloy, as it leaves the foundry in the form of castings, ranges between 12 per cent. and 15 per cent., depending upon the particular use for which the casting is intended. Except for special purposes, however, it is seldom above 14 per cent., above which the alloy is hardly machinable. The full analysis of the metal is usually somewhere between the following limits:—Silicon, 12 to 15 per cent.; total carbon, 0.2 to 0.6 per cent.; phosphorus, 0.16 to 0.2 per cent.; manganese, 0.25 to 0.35 per cent.; and sulphur, under 0.05 per cent. Antimony also is present in small quantities. Pieces of the metal, estimated to introduce 0.1 per cent. into the alloy, are placed in the bottom of the shank or ladle waiting to receive the alloy from the furnace, the alloy being run on to it, and the latter is soon dissolved by the flowing metal.

Physical Characteristics.

The alloy has a specific gravity of about 6.8 and a tensile strength of about 6 tons per sq. in. It melts at a temperature of about 1,200 deg. C., and contracts, after solidification, 3-16th in. to the foot.

Attention will be drawn later to the casting difficulties arising out of its relatively low tensile strength and high contraction, though, in the latter respect, the alloy under consideration compares very favourably with other alloys of a similar character.

Melting Practice.

The alloy is melted in the cupola like cast iron, though rather lighter charges are used than in the case of the latter. Before being used for castings, the metal is run down and then remelted. The raw materials used are wrought iron and steel scrap, scrap from faulty castings heads, runners, etc., of the same alloy, and ferro-silicon pig. Sometimes a little selected cast-iron scrap is used also. In calculating the charges, an allowance is made for loss of silicon of 0.5 per cent.

Two cupolas are in use, of 18 in. and 30. in. dia. respectively, inside the linings, the latter having a receiver attached which will hold some 25 cwt. of metal. In the case of the former, 1½ cwt.

* A Paper presented to the London Branch of the Institution of British Foundrymen on December 7.

charges are used, and, in the case of the latter, 3 cwt. charges. Coke and limestone are used in similar quantities to those used in cast iron melting practice.

Graphite Separation.

A very considerable difference is noticeable between the molten metal as it leaves the smaller cupola and that leaving the receiver of the larger. The metal leaves the tapping hole of the smaller cupola at a white heat. For a few inches from the hole, down the spout, the metal seems unchanged. As it travels further, however, it becomes smothered with a fluffy layer of dark matter, which travels with the metal into the waiting ladle or shank. In a very short time the metal in the ladle or shank is covered to a depth of 2 to 3 in. with the dark matter, which, when skimmed off, is found to be a mass of shining particles of graphite. The metal then may be carried to cast, say, an open sand ingot. When the shank or other vessel has reached the mould, and is placed on the floor preparatory to casting, the metal is found to be again thickly covered with graphite.

The metal is vigorously stirred, skimmed off, and poured. On completion of the casting operation the ingot is found to have another deep cover of graphitic matter. This may be drawn off with a skimmer, leaving the upper surface quite clean, and still very liquid. If this clean surface be watched, however, black patches may soon be seen upon it, coming up from below, until the surface is again nearly covered. This matter cannot again be skimmed off. On being examined later it is found to be mainly graphite. If the ingot, when cool, be broken across anywhere along its length, pockets will be found here and there full of glistening flakes of graphite. Such a section is illustrated in Fig. 1.

This factor is a frequent cause of scrap castings, the graphite separating out after entry into the mould, forming pockets in points of castings where two or more sections meet, or at upper surfaces of castings. Examples of this are illustrated in Figs. 2, 3 and 4. Castings which appear quite sound, however, may, on machining their upper surfaces have the appearance of Fig. 5, the dark points being finely distributed particles of graphite.

Receiver Metal is Blown.

The heavier castings are poured from metal melted in the larger cupola. To the bottom of the receiver of this cupola a 1-in. dia. pipe is laid, which is reduced to an aperture of $\frac{1}{8}$ in. dia. some 2 in. before reaching the bottom face of the receiver. Through this aperture, which is in the centre of the bottom of the receiver, air under pressure is blown vertically through the metal, the intention being to burn out carbon, as in converter practice. There can be no doubt that silicon is also oxidised at the same time.

Different Behaviour from Different Cupolas.

The metal from the receiver behaves in a markedly different manner from that which issues directly from the smaller cupola. No graphite covers the metal as it travels down the spout, and no graphite appears upon the top of the metal in the ladle—at least, not in the form in which it appears in the case of the metal from the smaller cupola. In this case the separation of graphite has proceeded rapidly in the receiver, the metal leaving much freed carbon behind it as it runs from the receiver. Though, however, there is a considerable difference in degree, the same kind of phenomenon is noticeable. Not much graphite of the shiny, flaky kind comes to the surface, but instead a graphitic kish appears, which very soon forms a heavy crust on the top of the metal. To get good results with the kind of castings for which the metal is used it is necessary to cast as hot as possible. The metal is therefore taken from the furnace, vigorously stirred, skimmed and poured. Though, as has been noticed, the tendency for separated graphite to appear is less in the case of the metal from the larger cupola than from the smaller having no receiver, it still remains a serious difficulty, pockets and fissures full of graphite frequently being found in castings poured therefrom.

Theoretical Desiderata.

At this point it may be worth while to examine briefly the factors which produce the effects which have been noticed above. It is generally granted, in competent quarters, that the eutectic of the iron-carbon series of alloys is reached when the alloy has a total carbon content of 4.3 per cent. This alloy freezes at about 1,130 deg. C. At the higher temperatures within the cupola, however, the metal may take into solution more than the eutectic amount of carbon. Within certain limits molten iron dissolves carbon very readily. It has been estimated that a saturated solution at 1,400 deg. C. contains about 6 per cent. carbon, though this figure may be greater at higher temperatures. As, however, the temperature of the metal falls to freezing point, the carbide in excess of the eutectic degree is precipitated, such carbide then being dissociated, iron and graphite each being liberated and kish produced.

If a third element, silicon, be added to the iron-carbon eutectic alloy, an important result follows, the solubility of carbon being materially affected. This phase has been examined by Wüst and Petersen. The results of 15 tests made by them are shown in Table I. Putting the data provided by these investigators in graphic form, a curve is produced as shown in Fig. 6.

Table I.—*Tests of Silicon-Carbon-Iron Alloys by Wüst & Petersen.*

Test No.	Silicon, per cent.	Total carbon, per cent.	Freezing point, Deg. cent.
1	0.13	4.29	1,138
2	0.21	4.23	1,131
3	0.66	4.05	1,156
4	1.14	3.96	1,155
5	1.41	3.88	1,160
6	2.07	3.79	1,175
7	2.68	3.56	1,185
8	3.25	3.41	1,187
9	3.69	3.32	1,197
10	3.96	3.24	1,205
11	4.86	3.08	1,210
12	5.06	2.86	1,215
13	13.54	1.94	1,123
14	18.76	1.19	1,240
15	26.93	0.87	1,255

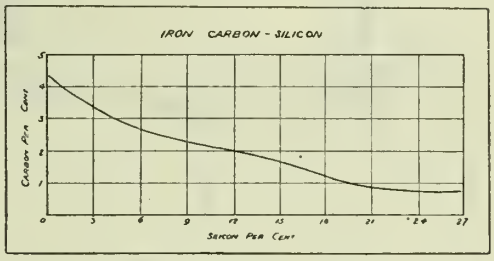


Fig. 6, showing the Fall in Carbon-Content with the Rise in Silicon.

The important points to notice in the table are (1) the regular fall in carbon content with successive increments of silicon, and (2) the equally regular rise in the freezing points.

In the course of Mr. J. E. Fletcher's illuminating Paper on "The Blast Furnace and the Foundry Cupola,"* it is demonstrated that for every 1 per cent. silicon which is introduced into cast iron, 0.286 per cent. carbon is thrown out of solution, and that for every 1 per cent. phosphorus which is introduced, 0.387 per cent. carbon is thrown out of solution at or before the moment of solidification of the metal.

The influence of manganese and sulphur upon carbon solubility in the small quantities which are present in the alloy under consideration may be regarded as negligible.

From the data provided by Wüst, Petersen and Fletcher, it would appear that an alloy containing 14 per cent. silicon and 0.2 per cent. phosphorus would have, on freezing, a total carbon content of approximately 1.6 per cent. Though, however, the carbon is low in the solidified metal, it may be, and doubtlessly is, high in the metal at temperatures well above freezing point. In the course of a series of interesting experiments which were carried out by Messrs. C. E. Williams and C. E. Sims (detailed in a Paper read before the American Chemical Society),† which were intended

* "Foundry Trade Journal," March 30, 1922.
† "Foundry Trade Journal," August 3, 1922.

to demonstrate the effects of various elements in influencing carbon solubility in iron, the writers conclude that, though the presence of a large quantity of silicon does decrease the amount of carbon dissolved in the frozen iron, it does not affect the amount of carbon which is absorbed and held in solution by the metal whilst in a molten condition. This conclusion is in line with that reached by the present writer as a result of his observation of the behaviour of high-silicon iron.

Carbon in Liquid Iron.

In what form the carbon may be present in the molten iron is not very clear to the present writer, whether definitely as carbides or not, though authoritative opinion appears to be to the effect that, at the higher temperatures, the whole of the carbon in solution is present in the form of carbide. What, however, does seem very clear is that an iron-carbon alloy containing 14 per cent. silicon and 0.2 phosphorus may hold, whilst molten and at the higher temperatures, a very considerable quantity of carbon, the excess of which, with falling temperatures, continues to separate out, right down to the moment of solidification. This, therefore, explains the presence of large quantities of graphitic kish which appears on the surface of molten high-silicon iron which has been melted in the cupola. It also explains the presence of pockets of free graphite in the castings made from the alloy, the separation continuing in the metal after entry into the mould, the kish floating to the surface or being trapped and held at other points.

Types of Castings.

Of many types of casting which are made in this alloy, including, amongst others, autoclaves, pipes, valves, cocks, pumps, pans and stills of various sizes and design, it may be said that the making of many of them present little difficulty to the foundryman other than that due to the separation of free graphite. The principal type of casting made, however, is a liquid-holding vessel of some shape or other. A casting of the shape and design of the circular pan shown in Fig. 7 presents little or no difficulty. It will be noticed that the top flange is relatively narrow and thick, whilst the diameter of the pan is equal to the depth. A good number of castings of this type have been made, some of considerably larger and some of smaller dimensions than those given in the illustration, without trouble—other than that due to kish formation. The castings are made in loam, and run from the top through three or four small rectangular sectioned runners.

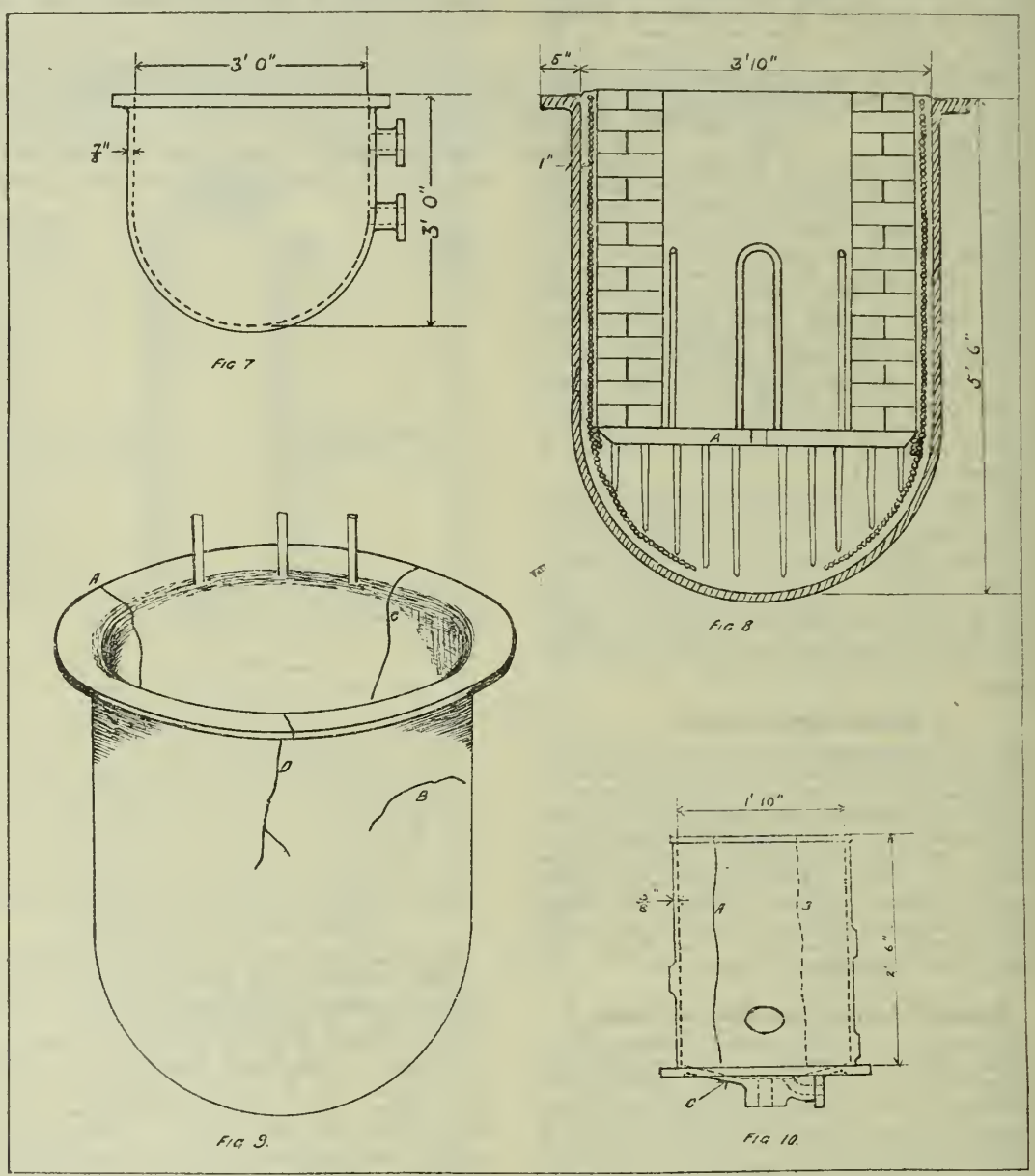


Fig 7 Fig 8

Fig 9. Fig 10.

Casting Problems.

Another pan, however, which gave trouble to the writer is shown in Figs. 8 and 9. The weight of the casting was about 23 cwt., the internal diameter being 3 ft. 10 ins., and the depth 5 ft. 6 ins. It is now an accepted principle among chemical manufacturers that the pans which they use shall be cast in the same position as that in which they will sit in use, *i.e.*, open end upwards. Fig. 8 shows the casting in section, with the construction of the core. The outside part of the mould calls for no comment, being built up in the ordinary way. In building up the core, however, four stripping bars, triangular in section (not shown in the sketch) and being the full length of the straight part of the core, were placed upon the top-plate, dividing the circumference of the core equally, and standing back 1½ ins. from the

strickle; a narrow edge of the bar being nearest the casting face. A 9-in. brick-wall was built up between the stripping bars, leaving the centre of the core hollow. On the top of this building was put the crown plate A (Fig. 8) carrying prods, the spaces between which were filled up with bricks and loam in the ordinary way. Before the loam was put on the building, hay-rope was wound round the core from the base (as moulded) to near the crown, a double line of rope being wound round the outer edge of the crown plate. The core was then struck up with the strickle.

After the core was dried and finished, hook-bolts were attached to the staples in the crown plate and pulled firmly up to the top-plate. Three runners were placed as shown in Fig. 9.

The mould was assembled and cast with metal, which would be described by most foundrymen as fairly hot. Twenty-five minutes after casting, the top-plate was taken off, the stripping-bars were pulled out, and six men, in relays of three, proceeded to dig out the brickwork down to the crown plate so that the latter could be lifted out. Just before the crown plate was lifted out, however, a crack was observed in the casting at the point A in Fig. 9, which soon spread across the flange and then down the casting for about 15 in. The casting was scrap.

Such a casting, if made in cast iron, would present no difficulty. The casting could have been left until cool before getting out. Nothing need be feared from the pull of the casting on the core. In fact, an outer pan in cast iron was made afterwards, being 3 in. greater in diameter, which was used to form a steam jacket for the inner pan, the making of which is described above. The same tackle was used, and the core was not touched until the casting was taken out some 48 hours after casting.

Diagnosis of Trouble.

In the case of the cracked pan, the difficulty was diagnosed by the writer as follows:—

When the top-plate was lifted off, a large part of the area of the top flange of the casting was bared, and, though the flange was at once covered with sand, the rate of cooling of the flange was greatly accelerated. The next step was the taking out of the stripping bars, followed by the removal of the brickwork from the core, down to the crown plate. This was rather a lengthy process, owing to the heat given off by the casting, the fumes, and the difficulty of getting out the bricks and other débris. Long chisel bars and scopes with long handles were used for this purpose. By the time, however, that the men had cleared out the bulk of the core, the top flange was getting black, the body of the casting below the flange remaining red. The flange began to contract strongly, whilst the body of the pan resisted, with the result that a vertical fissure started at the outer edge of the flange, proceeded across its width, and then straight down the body of the pan.

New Method Tried.

A second mould was made in the same way, except that provision was made for five runners instead of three. A different course was adopted in stripping the casting. As soon as the top-plate was lifted off, a good layer of warm sand was placed over the hot flange of the casting. A heavy, flat, cast-iron building-ring was then dropped upon the sand, overhanging both the outer and inner edges of the flange of the casting. The digging out of the core was then proceeded with as before. The idea behind this proceeding was that the top flange should be kept as hot as possible, so that cooling should be as even as possible throughout the casting. On examining the casting on the following day the flange was found intact. To the writer's dismay, however, a crack some 9 in. long was found going horizontally round the body of the pan, about 16 in. below the flange, as shown at B, Fig. 9. On examining the cracked part of the casting after it had been broken up, it was obvious that a film of graphitic kish, which had formed on the top of the rising metal at that place, had been held at the point of the crack. The clear metal had then risen over the ends of the film of kish, flowed over its length, and the filling of the mould then went on until complete. When the casting began to contract, however, a fissure would manifest itself at the line of the kish film.

Experiment Continued.

A third casting was made. Unfortunately the building ring, which had, on the last occasion, been used for the purpose of covering down the hot flange of the casting, had, in the meantime, been used in the construction of another mould which was of an urgent character. Instead, a light ring was placed over the flange. This was not sufficient, the casting cracking, from the flange downwards, in three places, at A, B and C in Fig. 9. When this casting was broken up, however, it was found that the cracks had started at points where kish had gathered.

Success Achieved.

A fourth casting was made, the heavy building ring again being requisitioned; a sound casting resulting.

It may be said, in criticism of this far from happy history, that it ought not to have been difficult to make tackle for the job which would have made it a simple matter to clear out the core without removing the top-plate from the casting. With that the writer would agree; but he would point out that the tackle for the job had already been made, prior to his appointment in the service of the firm concerned, and that by a competent loam-moulder who had been employed for many years at the same shop, making that class of casting. Further, it is seldom that two pans of the same dimensions are required. To make satisfactory tackle for such a job would be rather expensive, and, very probably, such tackle would not be found suitable for another job. Much progress might be made with this class of work if the castings were standardised as to dimensions. As it is, nearly every user of such vessels asks for a casting of a shape and of dimensions suitable only to his own peculiar needs. Looking back on the history of this job, one might admit that the immediately more expensive way might have been the cheaper—but these things have to be learnt by experience.

Details of Other Castings.

Another casting, a still, which proved rather difficult, is shown in Fig. 10. For casting in high-silicon iron, the walls of the casting were rather thin, viz., $\frac{5}{16}$ in.

The mould was made in loam, and cast, in the position shown in the sketch, through a number of small drop runners placed all round the top. After casting, the top-plate was lifted off and the core dug out. On the following morning, however, it was found that the casting was cracked from top to bottom, on opposite sides, as shown at A and B, Fig. 10. Another casting was made in the same way, but with the walls thickened to $\frac{7}{8}$ in., and with the top rim made heavier. When this casting was taken out, it was found to be sound round the sides, though the top rim was weakened and disfigured by deposits of graphitic kish. Further examination, however, showed that the casting was cracked round the boss at C, shown in Fig. 10. In the next mould, the core in the boss was chambered, and the weight of metal about the little branch pipe beside it reduced, with the result that the casting was successful.

Peculiarities Exhibited.

A peculiarity of the metal was shown when making a 6-in. pipe, 5 ft. long, a section of which is shown in Figs. 3 and 4. In the first one, the runner was put on the joint, as at A. It will not be denied that, in cast iron, pipes of this size may be cast successfully whilst run nearly anywhere—on the top of the flange, on the top of the pipe, on the joint, or in at the end. In this case, however, it was found that, when run on the point, the fact that the metal dashed against the core resulted in the production of more graphitic kish than usual, the top of the casting in the region of the runners presenting an unsightly appearance, being pitted with holes, which were full of shining graphitic flakes. So much was this so that the casting was useless. Another casting, which was run straight in at the end, as shown at B, Figs. 3 and 4, was quite sound, the easier flow apparently resulting in less separation of graphite. The reason for this is not very clear. It may be reasonably assumed, however, that as the metal falls in temperature, and carbon goes out of solution, much of it may remain mechanically mixed in the metal (an instance in which this was

perceptible to the naked eye is illustrated in Fig. 5) if not unduly agitated, but that, when violently disturbed, as when dashing against the core, the already precipitated graphite is more readily freed from its immediate surroundings, and floats to the surface of the metal.

Cascade Basins Give Trouble.

Another casting which is difficult to make is shown in Figs. 11 and 12. This is a small cascade basin, having an internal diameter at the top of 12 in. and a depth of 6 in. The thickness of the metal was $\frac{1}{8}$ in. This, like the other vessels discussed, must be cast hollow side upwards, necessitating the use of lifters to carry the inverted dome of sand. The only way the castings could be run was by means of six runners being placed on one side of the top rim, which dropped the metal right down the thickness. In order to prevent the moulds from scabbing, they were skin-dried. A few minutes after the casting operation the top part was lifted off. If this was left a moment too long the castings were cracked. If the mould was dried too deeply, it could not be separated sufficiently quickly from the casting. If they were not dried, or insufficiently dried, the casting was scabbed. To cut a long and painful story short, the losses due to scabbed, faint-run or cracked castings was so great that to continue to make them was impracticable. Resort was made to patterns having a thickness of 3/16 in., which were made quite successfully.

Definite Conclusions Drawn.

Arising out of the experiences related above, the writer ventures to draw certain conclusions. In the first place, it would appear to be imperative, if the making of castings in acid-resisting iron is to be put on a sound basis, that means should be found for freeing the metal of kish before entry into the mould. As carried on in the practice detailed above, the kish cannot be eliminated by any amount of shaking and skimming; at any rate, not at the temperature at which it is necessary to pour the casting. As has been shown, the graphite continues to separate whilst entering the mould, and after entry. Kish is not only a danger when it appears on the surface of the casting. The writer has been impressed by the fact that, in very many of the cases of cracked castings, the starting point has been a place which has been weakened by an accumulation of kish. It is fairly certain, further, that many apparently sound castings contain, somewhere in or about, hidden pockets of kish. Such castings may easily break down in work.

The cupola is a very good place in which to melt cast iron, but it is certainly not so desirable a means for the melting of high-silicon, acid-resisting iron. It appears to be clear that the really essential elements are iron and silicon. Therefore the alloy should be made from materials which are almost carbon free, and melted out of contact with that element, or in such circumstances as would make possible the control of the carbon content, to ensure the presence of no more carbon than could be held in solution by the metal at the moment of solidification. The electric furnace would appear to offer the means of achieving this.

More thought should be devoted to the design of castings in this alloy. Broad flanges should be avoided. They should be as narrow as possible, and relatively thick. Greater care is needed than in the case of cast iron to secure even thickness of sections, owing to its greater contraction and lower tensile strength. The chemical manufacturers who make use of castings in the alloy should reach some agreement with a view to standardisation of sizes and shape of pans and stills. The tendency to make pans deeper in relation to their width should be avoided, as this seems to make successful castings more difficult.

General Conclusions.

In conclusion, the writer is convinced that, these conditions provided, castings could be made subject to no more risk than that which is experienced in the making of castings in cast iron. The alloy itself is considerably more expensive than cast iron. On the other hand, the alloy's power of resistance to the action of certain acids has been estimated to be 1,000 times as great as that of cast iron, which should mean that the high-silicon iron casting, for certain purposes, will have 1,000 times the working life of an iron casting of similar dimensions. Therefore the additional cost is more than justified; and steps made to perfect the manufacture of vessels in this or similar alloys should be much to the advantage of the chemical manufacturing industry, as well as to that section of the ironfounding industry which specialises in this class of castings.

Working Slags.

Mr. J. E. Fletcher introduced a Paper recently read before the Birmingham Metallurgical Society by the remark that the old idea that slags in both ferrous and non-ferrous processes were simple by-products functioning as cleansing fluxes or fluxes for preventing oxidation was entirely misleading. Modern research has proved, he said, that the working slags play a much more important part. They are as indispensable in the production of the finished metal as is air in the life of the human being. It is by the control of the composition, both chemical and physical, and of its temperature that a liquid slag may supply the oxygen necessary for converting a bath of crude cast iron into excellent steel or bring it into the condition suitable for puddling, whereby a spongy ball of nearly pure iron is produced. Or again, the working slag may be supersaturated with such alloying metals as will pass into the liquid metal and produce, in the blast furnace for example, pig-iron alloyed with pre-arranged quantities of silicon, phosphorus and manganese, or produce in steel furnaces alloy steels.

The author then outlined the functions fulfilled by the slag in the blast furnace, the cupola, the Bessemer converter and the basic and acid open-hearth furnace; the changes in the composition of slag were shown in typical charges, and the influence of viscosity on the speed of reactions described. The chief point emphasised was the important tendency for liquid ferrous working slags, under conditions of high superheating beyond their melting points, to arrive at a stable equilibrium when the acid and basic oxygen contents of the slag were exactly balanced. When this point was reached the alloying or oxidising actions ceased, and could only be altered again by metallic oxide additions which destroyed the inertness of the slag. The progress of slags towards this inert condition was graphically shown by diagrams indicating the changes in the slag composition during typical heats in the blast furnace, and in iron refining, puddling and steel-melting processes. The difficulty of understanding the slag function by means of analyses of cold slag was pointed out, and the necessity for correctly deduced compositions of the slags emphasised.

From analogous researches in the domain of igneous rocks and refractories the author indicated the likely oxide combinations in the slags of ferrous processes when such slags were heated beyond certain temperatures corresponding with the change from the meta-stable to the stable condition or *vice versa* when the slags were cooled, in which condition only they were capable of being microscopically examined and their physical constituency determined.

The Sydney (N.S.W.) City Council has reversed its previous decision and has awarded the contract for the supply of meters to the Electricity Meter Manufacturing Company, of Sydney, the price being £42,906. A previous message reported that the Electricity Committee recommended the acceptance of a tender made by Noyes Brothers for the supply of 25,000 English meters at a cost of £42,936.

A "trade barometer" is to be prepared for the guidance of manufacturers and traders. It will take the form of a statistical service for business men, and is to be produced under the auspices of the Economics Department of Cambridge University and of the London School of Economics. The aim of this service is twofold—first, to assist manufacturers in forecasting the trend of business in the near future; and, second, to undertake from time to time researches on specific subjects, such as the volume and movements of foreign trade, stocks of commodities, the position of freights and shipping, etc.

Gating, Feeding and Casting.*

By E. Longden, A.M.I.Brit.F.

Much controversy has, during the last few months, centred around the possibility of producing castings without feeding heads. Monsieur Rouceray is responsible for the strong limelight which has been directed on the whole question of producing sound castings by slow pouring. His theories are far from being new. Slow running has been practised for very many years, but only in very special cases, some of which will be referred to later.

At the outset, it should be stated that equally successful results can be more easily and economically obtained, in the majority of cases, by pouring quickly. In so doing success lies in admitting metal to a mould in such a way that the temperature of the molten mass is as uniform throughout the mould as can be obtained.

The contentious nature of the Paper is realised, but it should be pointed out that in the examples to be shown exceptionally good results have been obtained.

Grey cast iron will, in the main, be the material discussed, and, as the properties of the metal must be kept in mind, it is proposed to survey some of its peculiarities and the effect of various elements in reducing or increasing fluidity, because this property is so very important.

Fluidity.

Fluidity is the property the metal has of flowing easily, thereby filling completely the interstices and parts of the mould. The principal factors which govern the fluidity of molten cast iron are: Degrees or amount of superheat above melting temperature as the metal leaves the cupola; available freezing point as determined by composition. A metal must be superheated considerably to get good, clean fluid iron.

The amount of combined carbon governs the melting temperature, and higher the total carbon, the longer the period of cooling. As is well known, the life or superheat of grey iron is much greater than either white iron or steel. A white iron contains a large quantity of combined carbon and only traces of precipitated carbon. In soft grey iron the bulk of the carbon is in the graphitic state. Since the combined carbon determines the melting temperature, white iron will melt more readily than grey iron. Fortunately for the usefulness of grey cast iron, the graphitic carbon must be first dissolved before the melting point is reached, resulting in a considerable amount of heat being rendered latent, which is equal to a superheating of from 260 to 280 deg. C. The melting temperature of grey iron is about 1,250 deg. C., and white iron about 1,120 deg. C.; therefore, molten grey iron possesses much more life. Silicon reduces the stability of iron carbide, and during cooling compels the carbon to precipitate or separate from combination; in so doing heat is given out and the life or fluidity of the metal prolonged. Grey iron, therefore, freezes at a much lower temperature than its melting point.

Phosphorus increases fluidity to a considerable extent. Phosphorus eutectic becomes fluid at 950 deg. C., and if the structure of the metal is sufficiently close to prevent undue segregation, it imparts superheat to the whole of the metal.

Sulphur, by favouring retention of combined carbon, reduces fluidity.

Manganese may or may not help the fluidity. Its action in forming manganese carbide tends to harden the metal, but the decrease in fluidity is not marked. By its affinity and readiness to combine with sulphur, etc., it may be said to increase the fluidity.

Aluminium precipitates carbon, combines readily with oxygen, and thus increases fluidity.

Titanium removes oxygen, and magnesium, dissolving very easily in cast iron, also favours fluidity.

Dissolved Gases.

Recent investigation has proved that much of our defective casting trouble is due to dissolved gases. Those elements which favour the removal of the gases, principally oxygen, without in place imparting some deleterious effect, will, in the future, be more extensively used. The gases occluded are mainly carbon monoxide and hydrogen. Oxygen unites with the carbon in the metal-producing carbon monoxide, possibly producing most of the gas holes disclosed after machining a casting.

Oxidised iron flows sluggishly and congeals comparatively quickly, thus preventing adequate feeding of the casting. Quite distinct shrink holes often result, and are usually found in the proximity of the gates. Very often the defect is shown immediately the runner or riser gate is broken. Some authorities on metals claim that oxygen strengthens the metal, but it seems quite clear that it is associated with hardness, higher shrinkage and gas holes. Gases will ascend by way of the fluid centre of the metal, so that, if the metal be sluggish, a considerable amount of the gases might be trapped, to be disclosed when machining. It is supposed that the feeding process is necessary to replace gas displaced as the crystals grow. But all metals, with one or two exceptions, shrink, independently of gas. Even grey cast iron is not an exception, in spite of the compensating effect of the precipitation and growth of graphite. Low carbon-content will give rapid freezing and increase the danger of locked gases.

In the softer grades of iron little trouble is encountered from trapped gases when compared with the hard cylinder variety.

Introduction of steel into grey-iron mixtures compels special attention to the necessity of obtaining plenty of superheat and rapid pouring facilities.

Metallic oxide is a source of great trouble in both ferrous and non-ferrous castings. Iron oxide very often causes shots, gas pockets, pin holes, interior shrinkage, imperfect filling of the mould, cold shuts and local hardness. The two latter faults are caused by an imperfect amalgamation of two separate streams of metal when meeting. In spite of high temperature and high phosphorus, such trouble is encountered when iron oxide is present in considerable quantities.

The last metal from the cupola is often oxidised, rendering it unfit for work of great importance.

A low melting temperature tends, in addition to oxidising the metal, to hold slag in suspension. Slag thus entrained may find its way into the casting. Gases very often attach themselves to the first solid material encountered, and are sometimes associated with suspended slag.

Temperature and Colour.

In the grey-iron foundry the pyrometer is little used. Temperature is judged by colour. Care must be exercised in judging metal by colour. A milky-white low-silicon iron may have a lower temperature than a dull-red high-silicon iron. Generally, the colours are spoken of as, in white irons, from red to milky-white and in grey iron from orange to light yellow. When viewed in the ladle, grey iron does not present quite so smooth a surface as white iron.

About 20 per cent. of the heat present in well-melted grey iron must be dissipated before setting, which means a drop in temperature of somewhere about 150 deg. C. White iron must only get rid of 75 deg. C.

Teeming Temperatures.

Careful control of pouring temperature to suit the type of mould, dry or green sand, and class of casting is very desirable. It is true to say that each distinct casting has its own correct teeming temperature. In light and heavy high-class work, such as cylinders, liners, pistons, etc., metal should be poured white hot, care being taken not to cast until any boiling which might be present in the metal, due to an excessively high temperature of melting, be stilled. To refer to extreme cases, one would not think of casting a heavy hammer-block or flywheel with white-hot metal or a motor-car cylinder with dull iron. Mass can be run stiffly.

* A Paper presented before the East Midlands Branch of the Institute of British Foundrymen.

What Happens when Iron Cools.

There are three stages in the cooling of molten iron—liquid stage, solidifying stage and solid stage. Shrinkage takes place from liquid to solid. Contraction should be termed as a decrease in volume from the solid to normal temperatures. Most foundrymen's energies are directed in trying to obtain the combination of good liquid shrinkage and free escape of gases.

A great amount of interest is aroused in locating gates. Nothing in a moulder's work requires more consideration. Temperature and the way in which metal is admitted to the mould determines either a waster or good casting. Would it be exaggerating to state that one-third of all castings scrapped are due to incorrect pouring, gating or feeding?

Molten metal, on entering the mould, gives up heat to the surrounding sand, and the greater the distance it travels, the greater the cooling effect on the metal. One can imagine the journey of the metal through a mould of some size. In some parts eddy currents will be produced, in other places it will become stationary, whilst in other parts a more rapid filling takes place. It is evident that it will be impossible for some parts to be "freshened up" with clean hot metal. These variations result in unequal times of setting, apart from the question of thickness.

Runners and Risers.

There are various types of runner-basins, runner-gates and risers. The runner-gates, which are quite familiar and about which little need be said, might be included under the terms "drop," "cut," "worm," "skim" and "fountain" gates.

Choice of runners should be determined according to location, capacity for distribution, and filling the mould with metal at as nearly as possible uniform temperature, and the subsequent effect on shrinkage and distortion. The size, shape and position of channels by which metal enters a mould must be the first consideration. Although much can be foreseen, it sometimes happens that size, number and position of gates can only be determined by experiment.

Moulders usually look for a heavy section, through which to admit the metal. Very often this is a great mistake. He may succeed in distributing the metal quickly and save a scabbed casting, but it is obtained at the expense of producing drawn places in sections already overburdened with heat. Success in making steel castings is more easily achieved by observing this fact. Possibly a casting need not be fed if due care is taken in placing the runner.

Top and Bottom Running.

Both top and bottom pouring methods are in turn praised by respective advocates as being the correct way to run certain castings. Bottom pouring is the safest when working in green sand, but even then not always the best. In all dry-sand work of cylindrical form, which must be machined, the best castings are produced by top pouring through a series of round or elliptical pencil-like gates. The metal is kept agitated, which prevents dirt or gases sticking to the sides of the mould and core, at the same time allowing a uniform shrinkage to take place. Often the best results are obtained by a combination of top and bottom pouring, as in the case of various cylinders, for gas, oil and steam engines. These are filled in by a bottom-runner until metal rises past awkward and projecting portions of the mould and cores, and then flushed with the top gates. With top pouring, consideration must be given to the effect of the blow delivered by the metal when it strikes the mould. If a little metal is first admitted by way of a bottom runner, a cushion is formed to receive the bulk of metal from the top runners. Gas cavities are formed by using bottom runners only. Shots and buttons may be formed by using top gates alone.

Dirt will not collect around in-gates if constructed and located correctly. Dirt and gases are often found far away from the runner entrance. Near the runner it will be found to be dirty if flow of metal is impeded. Sometimes a piece is cut out of mould at the place where the dirty accumulation occurs. Sponginess above and about a runner is due to excessive heat generated at one spot.

The amount of metal delivered is determined by the orifice. Obstruction, friction and change of direction tend to reduce the amount of metal delivered. Round gits of same area as rectangular ones will run more quickly, because there is less surface area. Runners, if too small, will choke if metal is not hot.

The velocity of the metal at mould entrance is reduced when using horn and skim gates. Both are efficacious in certain cases. When admitting metal at a tangent, the swirling motion tends to gather the scum in centre and top. Very good results can be obtained by arranging a number of small gates instead of one gate with same area. It is preferable to break up the gates wherever possible.

Pouring Speeds.

There are times when a mould needs to be filled slowly, and at others quickly. Rapid pouring necessitates good venting. With rapid pouring, a greater shock is delivered on the top part of the mould at the moment when filled. It would be disastrous to pour slowly a mould with large surface area; unless the top part was protected somewhat by cores, it would draw in, due to this part of the mould being subjected to a prolonged and fierce temperature. Slow pouring is necessary when a mould contains thin, dry or green-sand cores; more time is thus given for escape of gases, but the metal must be hot.

Test-bars, whether attached or unattached to castings, should be so placed that no more metal is poured through them than necessary. It is advisable to keep the test-bar mould as cool as possible and to run horizontal to get good results.

Runner gates in heavy and medium work, and also more rarely in small work, are often made in dry-sand cores.

When not desiring to go to the trouble and expense of a dry-sand mould, pieces of dried core are placed opposite and about the in-gate, especially if there is the necessity for a thin, narrow runner with its cutting action. Wire nails are sometimes stretched across the metal channel to break up the stream, so that scum may be collected in a knob formed in the upper part of the in-gate.

Riser Gates and Feeding Heads.

It is quite evident that iron, on setting, shrinks, and in many cases feeding or pumping is resorted to. This is so, in spite of the compensating effect obtained when carbon is thrown out of solution by the action of silicon. A soft grey iron contains the great bulk of its carbon-content in the graphitic state; such an iron requires less feeding in heavy sections when compared with a harder variety, unless the metal is overburdened with phosphorus, with the consequent danger from the phosphorus eutectic.

Shrinkage is a term used to describe the reduction in volume which takes place when a metal congeals from the fluid. This shrinkage gives rise to cavities or porous places in the heavy-sectioned part of the structure; it indicates an insufficient feeding of metal during setting. Cast iron is not homogeneous, and it might be true to say that there are no absolutely quite sound castings.

To supply the additional metal consequent on fluid shrinkage, feeding is resorted to, using an iron rod, pumping metal through the riser gates, mainly, and runner gates. Sometimes the runners and risers are subjected to a pumping movement, not using the rod, the object being to keep the metal moving on the top side of the mould, thereby preventing it solidifying before the mass below. Occasionally the gates are neither pumped nor rod-fed, hot metal being poured into them from time to time. In certain cases this method is preferred rather than risk the danger of the casting being spoiled, due to excessive use of the feeding rod. When feeding a heavy section with a rod hot metal must be supplied from time to time after taking out the stiffened iron in the riser bush. In the case of certain heavy castings, which are fed over a prolonged period, a reserve number of loose riser-bushes are made. After a period, and when the metal in the riser head congeals from the outside, thereby restricting the movement and feeding by the rod, the whole bush, with its solidifying and solid metal, is torn off, and a new bush substituted which is filled with hot metal.

(To be continued.)

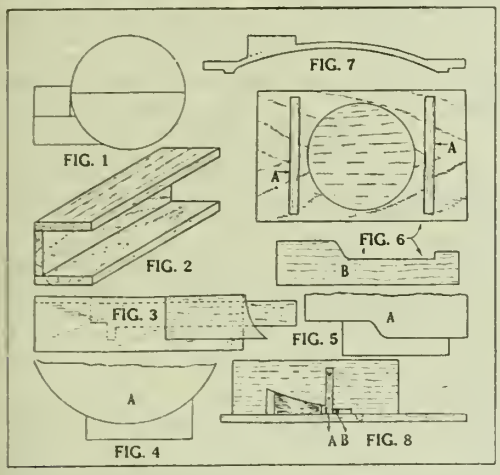
An Apprenticeship Course in Foundry Practice.—XXI.

By Ben Shaw and James Edgar.

BUILDING PATTERNS. EXAMPLES OF DIFFERENT TYPES.

When jointing the various parts of a pattern to the main body, it is not sufficient merely to aim for accuracy in measurement, but due consideration must be given to the handling the pattern will have to undergo when it reaches the foundry. Some craftsmen are very efficient at building pattern bodies, either by the segmental or staving methods, but they are failures at assembling the various parts together. The fitting of a branch to a circular body is not a difficult operation, but one man, by exercising judgment with good methods, will do it in a fraction of the time taken by another.

When the main body of a pattern is finished, either at the bench or in the lathe, the first operation, before any assembling is started, should be the marking off of centre lines for branches, bosses, and ribs. Too much care cannot be taken in doing this, because, where there are several branches at different angles from each other, a slight inaccuracy of one may cause a mistake to be made in the machine shop, which may spoil the casting. Some pattern-makers are comparatively careless in building work, and rely on the checker discovering any serious mistake, but the skilled



workman endeavours to finish his work so that no final adjustment or alteration is necessary. It is always possible to get centre lines on patterns, and in this respect the surface gauge is often invaluable. An irregular-shaped pattern may frequently be supported on a flat board, while the surface gauge is used for marking centres. With other patterns, hermaphrodites or "jennys" used from the backs of flanges serve the same purpose, while difficulties are sometimes overcome by means of a template and a "doctor," or a box square may be profitably used. The long toothed-gauge is another tool that is invaluable for making centre lines or branch joint lines that are parallel with the main pattern centre. We have already discussed drawbacks or false-cores at considerable length from the moulder's point of view, and the pattern-maker's point of view is not essentially different. Whenever it is practicable, the pattern-maker should define the moulder's joint. In what may be termed regular-shaped patterns this is a simple matter, but in many other cases it is not so. For repetition work, the first cost is of less importance, and, with small work especially, the moulders' joint can usually be defined when constructing the pattern. With some patterns it is possible to indicate the joint, and, in other cases, such as with pipes and certain valves, while the body of the pattern may not be jointed, flanges and prints are jointed, a practice which assists the moulder very materially. If often happens that branch centre lines are not on the same plane as the main pattern centre lines, but parallel to it, and it is really more difficult to fit a solid branch, and much more inconvenient for the moulder. Even when the branch is in halves, the half which is loose must be jointed to the main body, so that it will withdraw freely from the sand; it may be cut square and a small part fastened permanently (Fig. 1.). When fitting branches and bosses, some craftsmen are satisfied with a three-point contact, while others carve until they get a solid bearing. For work that is very urgently required, and which will only be used once or twice, a three-point contact may be quite satisfactory, but it is not for first-class work. As a general rule, branches that are imperfectly fitted are easily shifted from the correct position. With large branches, however, it is quite good practice to undercut the centre and make a bearing edge about $\frac{1}{2}$ in. wide, which can be quickly fitted and yet keep the branches quite rigid. Chalk and colouring is far too much used when building patterns. It is nearly always possible to get a fitting outline within an $\frac{1}{8}$ in. or less of the finished measurement, and any "marking" should only be used to ensure a bearance over the entire surface.

Fitting Branches.

When fitting branches, a knowledge of geometrical projection—a subject that will be dealt with in a future article—is invaluable. But it should not be made a fetish of, and the apprentice, while knowing how to get "points," should always endeavour to devise jigs and templates that will serve the same purpose. The commonest fitting for a branch is at right-angles to the centre line of the main body, and the simplest method of doing it is to use a box similar to Fig. 2. This consists of a channel section structure of 1-in. timber, and every pattern-maker who does much valve or pipe work should make two or three to accommodate large, medium-sized, and small branches. The branch is screwed to the vertical side A, then a template sprigged on the top, after which the fitting outline can be cut at the bandsaw with very little bench-work necessary. Fig. 3 shows the jig ready for cutting. Branches that are at an angle to the main body centre can also be readily sawn on this jig, the work being screwed on the vertical face at the correct angle.

While the above method is very usual when fitting a branch on a plain cylinder, it is only useful for roughing down when the pattern body is of several diameters, and it is also limited in its application when a fitting tongue is being cut from the solid branch. In the latter case the tongue should first be made perfectly parallel, and cut to the same width as the recess in the body, after which the jointing must be done with the pattern joint upwards. When no tongue is fitted, the most accurate butt-joint can be made by fixing the body pattern to the drawing-board and bedding the branch against it until the face of the flange is the required distance from the main centre line. In the case of a branch, the centre line of which is below the main centre line, the same procedure can be adopted, but a pad piece corresponding in thickness to the distance between the two centres must be screwed to the drawing-board.

Fitting Bosses.

For the fitting of bosses, much that has been said above is applicable. Unless they are on the pattern-joint, however, it is good practice to fit them larger than the required diameter, and saw them to shape afterwards. It may even be wise practice to plane the face of a boss and draw the shape when screwed in position. Fitting may, however, often be obviated altogether, for bosses and for branches also, where they are short and have not been turned with flange and print. The method is worth describing, because there is a big variety of work for which it is effective. Let us suppose, for instance, that at Fig. 4 we have a large diameter body A, with a boss B fitting to it. This boss B might be circular, oval, or rectangular. If rectangular, the shape should be drawn on the ends and planed or gouged through. If circular or elliptical, the block might, in the first place, be made square and fitted, after which it could be

sawn to shape. If, however, the body is of two diameters, as in Fig. 5, fitting the branch becomes a more difficult operation, and the quickest and most satisfactory way of doing it is by means of a rig similar to Fig. 6, the guides AA being shaped to the cylinder diameters, while a template with a check-piece defines the shape, which is cut with gouges. Branches and bosses of almost any shape can be fitted in this way. For a domed shape, whilst the principle is the same, the rig necessary is somewhat different. Fig. 7 is a very common saucer-shaped condenser-door. The manhole A, if fitted direct, constitutes an awkward job. It is quite possible—indeed, it is not very difficult—to get a series of points which, with the aid of a "doctor"—steel spring—to make a line representing the fitting line, but even then, however carefully the work is cut, further contact fitting would be necessary. This is a case when fitting may be a dual process, involving geometry and template. The drawing-board, if it is quite straight, is suitable on which to shape the manhole, which is screwed to the board at the correct distance from the centre. A template similar to Fig. 8 is made with a dowel as shown. This, of course, gives the accurate fitting shape. If the job is very large, instead of the template swinging from a centre, it could be guided by a circular strip A, fastened to the drawing-board with a corresponding check B on the template, as indicated by the dotted lines at Fig. 8. This is a method that is often adopted when a loam body is made in the foundry for a cylindrical pattern, and the details made of wood have to fit accurately in position.

Fitting Ribs.

Ribs are equally as difficult to fit as branches or bosses, and sometimes much more so. If a rib is in a vertical position in the mould, unless it has been very carefully fitted, it may tear the mould badly when being withdrawn. Thus it is always advisable to taper ribs as much as possible. Even when the position of the ribs is given on the drawing, and this is not always done, the patternmaker should scrutinise the design carefully, to make sure that bolt holes are not being fouled and also that the rib will not be in the way of other connections. Unlike bosses, ribs have to be fitted the finished thickness, and whilst one patternmaker will make one or two marks on the pattern, by means of a long-toothed gauge or a surface gauge, another more methodical workman will pin strips temporarily on the work, against which the ribs can be pressed when being fitted. The latter is the more satisfactory way, as a better fit is almost invariably obtained and in a fraction of the time that would otherwise be taken. When ribs are on a pattern joint they should invariably be "let into" the pattern. As to whether, in such cases, it is better to split the rib and fit a half thickness to each pattern section depends to a great extent on the size of the work. Thin ribs should not be split. If they are checked into the drag half of the pattern the top half may be recessed to clear or the ribs may be reduced in thickness to allow of a close joint being made. When a rib must be left loose in order that it will deliver from the sand it is advisable, when it is practicable, to check it or house it into the pattern, and when this course presents difficulties, to insert dowels, even if they are of wire 1-16 in. thick.

A serious fire broke out at the premises of the South Wales Electric Welding Company at the King's Dock, Swansea, on Monday, considerable damage being done.

Owing to the heavy increases in the already high poor-rate, the principal iron and steel manufacturers of the Darlaston district appointed a deputation to wait upon the local Board of Guardians to emphasise the serious effects to trade of such a heavy burden. A petition was presented, in which it was stated that the present high rates were crippling the industries of the district and were responsible in a very great measure for the unemployment which exists. They further point out that unless the present rate of expenditure is curtailed, and greater supervision exercised, operations will be suspended and works will be closed, and in consequence conditions would become even worse than they are at present. The petition was signed by nineteen firms in the Darlaston area.

"Perfect" Castings.

By F. C. Edwards.

There are few words in the English language capable of so many interpretations as that of the adjective "perfect." The reason is, of course, that no two individuals think alike; and, in balancing points, "perfect" agreement as to what constitutes "perfection" is, therefore, seldom attained.

Where castings are concerned, this diversity of opinion is often the cause of friction between the foundry and other departments. Furthermore, it is a frequent source of scrap. It does not seem to be sufficiently realised that, though a casting may occasionally be produced, say, for exhibition purposes, which, as the acme of perfection, may be termed "a work of art," efficient production must of necessity lie in a less elevated region of accomplishment. In common fairness to the foundry, then, the term "perfect" may be quite justly applied to castings that are best suited for the particular purpose for which they are ultimately intended—*judged in the light of every-day foundry practice.*

The root of the trouble is sometimes found in the assumption on the part of the drafting room that the foundry can produce any casting which human ingenuity can devise. Such an assumption may, indeed, be literally true, but ordinary practice imposes limits to the possibilities of the foundry if "perfect" castings are to be turned out as a commercial proposition.

Another fruitful source of disagreement as to the application of the term "perfect" is found in the attempt to reduce machining allowances beyond a reasonable irreducible minimum. A sand mould never will produce a casting as uniformly "perfect" as a die casting can be produced; if it could do so there would be no need for any machining operations. Perhaps it is because this is so obvious that it is so often overlooked. Particularly is this the case where broaching and similar operations are carried out on mass-production components. Here, on account of the fine margin allowed, castings are frequently rejected that would be regarded as "perfect" by all practical foundrymen, "perfect," that is, when judged by those who possess a clear and adequate conception of all the factors operating in the production of castings.

Or, again, the foundry may be in the dark as to the ultimate purpose of the casting; where machining is required; where—for some special reason perhaps—it is essential that the casting should agree "perfectly" with the pattern; where, in order to secure continuous uniformity of shape, gates may or may not be placed. Who has not seen an unsightly mess left, after the removal of the gate, on an otherwise "perfect" casting? Perhaps the position may have been the best from the moulder's point of view, but if he had known that his gate (badly trimmed off, perhaps) would be the first thing to meet the eye on the casting, he would probably have found for it a less conspicuous position.

Here, a slight modification in design would often enable the foundry to overcome the unsightly finish left after the removal of the gate, and so the more easily to produce the "perfect" casting. For example, one frequently finds a casting somewhat concave round about the gate, which cannot be ground out without taking that part of the casting below the general level; and if the castings are thin, say $\frac{1}{8}$ in., the case is hopeless. But by giving to the sides of the castings where they are gated a convex instead of a flat surface—which can often be done without materially affecting design (it may, indeed, enhance the appearance of the casting), the gates can be removed as neatly as though they had never existed, and in this particular, at least, "perfection" may be attained.

It would appear, therefore, that a working agreement as to the meaning of the term "perfect" can only be reached where the designer, on the one hand, has a clear conception of foundry possibilities, and keeps his required standard of foundry attainment within reasonable bounds and, on the other, where the foundry is well-informed as to the uses to which the castings are to be put. Obviously, efforts made towards "perfection" tend to reduce the percentage of waster castings.

Manufacture of Synthetic Cast Iron in the Electric Furnace.*

The author discusses experiments carried out in 1918 at Portland, Ore., with an electric furnace of 600-kw. capacity, and others made in 1919 in a 2-ton furnace of 750-kw. capacity. Firebrick was used in the arch and the lining of the furnace, and silica for the bottom, after trials with carbon bottoms had been abandoned. When smelting turnings and borings the most efficient operation was obtained by charging every 30 min. and tapping every 2 hr. A charge of 200-300 lbs. of anthracite was first placed in the furnace bottom, followed by the turnings and borings and the coal, silicon, manganese, lime, and spar. During the operation the molten iron filters through a layer of 4-6 in. of incandescent coal and becomes thoroughly carbonised. When semi-steel is required but little carbon is added, and it is found better to run single charges and melt down the complete charge before tapping. The author describes the production of pig-iron and grey iron for direct foundry use, and the action of the lime and spar used for forming a basic slag. Analyses are given of consecutive heats to demonstrate the control of the electric furnace in producing pig-iron and foundry iron. The operating costs per ton of iron tapped from the furnace (not including fixed charges) are tabulated. It is stated that working one shift per 24 hr. the cost is $40.33; two shifts, $30.18; and three shifts, $27.4; with power at 1.25, 1, and 0.8 cent. per kw. for one, two, and three shifts respectively, and scrap at $10 per ton. Smelting iron ore with scrap is not considered to be economical owing to the greatly increased power required to smelt the ore.—W. L. Morrison. (*Chem. & Met. Eng.*, 26, 312-316.)

Paris Congress and Exhibition.

At the last meeting of the Council of the Association Technique de Fonderie, Mons. Ramas presiding, the General Secretary, Mons. Camille Didier, brought to the notice of the meeting the letters received in answer to the invitations sent to the American Foundrymen's Association and the Institution of British Foundrymen. He was pleased to note that the Americans had promised their support, but the British had made reservations. Mons. Ronceray was requested to continue negotiations in order that a favourable reply might be received from the British association.

The position of the Institution of British Foundrymen with reference to this is to be re-considered at a meeting to be held in York next Saturday, after which no doubt the position of the British will be quite clearly defined. We can assure the Institution that there should be a reasonable response, if our appeal can be taken as any criterion. No less than fifty applications for detailed information have been received, emanating from large foundries, the President and past-Presidents of the Institution.

If, ten months before the Congress, fifty people propose to take part, the French Association can rest assured that by next September they will have good representation from the British, and the Institution on their side can rely on adequate support for any effort they may put forward.

London Branch Annual Dinner.

We are asked by the honorary secretary of the London Branch to announce that any members of the Institution who will be in London on December 15 are cordially invited to the annual dinner, which will take place at 7 for 7.30 p.m., at the New Villa Villa Restaurant, Gerrard Street, on this date. Tickets are 10s. 6d.

Mr. William Patterson, of Heaton, who was for many years in the employ of Sir W. G. Armstrong, Whitworth & Company, Elswick, and who since 1914 had resided in Glasgow, and acted as inspecting engineer for the firm in Scotland, has died.

* Institution of Civil Engineers Abstract.

Trade Talk.

The reduction of 4s. per week in the wages of employés in Admiralty dockyards was put into operation last week.

A large number of men at the Central Engineering Works, Ystradmynach, in the Rhymney Valley, came out on strike last week owing to a wages dispute.

The Laxey lead mines, near Douglas, I.O.M., which were only re-opened three months ago, have been seriously damaged by fire, but work is being continued underground

Richard Thomas & Company, Limited, are at present constructing a wharf at Llanelly, at which the company propose breaking up an obsolete warship they recently acquired.

Mr. Alfred C. Turner, 23, Budge Row, Cannon Street, E.C.4, has been appointed London agent for the General Refractories Company, Limited, of Kelham Island, Sheffield.

The business of Albert Day & Sons, iron and brass-founders, of Mark Foundry, near Highbridge, Somerset, is offered for sale. Arrangements are in the hands of J. A. Palmer & Sons, Burnham-on-Sea.

Major J. Caldwell read a paper on "Electric Welding," illustrated by experiments, at a meeting of the Yorkshire Association of the Institution of Civil Engineers, held on November 24, in the Philosophical Hall, Leeds.

The members of the Sheffield Tool Trade Technical Society met recently in the Mappin Hall, Department of Applied Science, Sheffield University, when Mr. A. W. Macaulay read a paper on "Ball Bearings." Mr. M. W. Clayton presided.

Arthur Lee & Sons, Limited, Crown Steel and Wire Mills, Bessemer Road, Sheffield, have established a London branch office of their own at 40-43, Norfolk Street, W.C.2. Hitherto the company have been represented by B. Holland & Company.

"Industrial Wastes" was the subject of an interesting discussion at the last monthly meeting of the West Cumberland Association of Chemists and Chemical and Metallurgical Engineers, at Workington. Mr. G. J. Valentine presided.

Notice of the termination of the agreement of 1918 has been posted at Vickers' shipyard, Barrow, which will reduce the number of men employed as platers' helpers. The unions are protesting against the reduction and ask for a continuance of the agreement.

The Newcastle Branch of the Institution of British Foundrymen met on November 29 in the Neville Hall, Mr. H. J. Young (president) presiding. An interesting lecture on dry sand moulding was given by Mr. J. O. Nicholson, and a long discussion followed.

E. Capper Robson & Company, Limited, will in future trade as Robson Refractories, Limited, the latter company having now taken over the sole selling rights of "Cupoline" for this country. The address remains the same, namely, 1, North Road, Darlington.

According to "Lloyds' Register of Shipping," 80 vessels of 93,715 tons were totally lost, condemned, etc., during the quarter ended June 30, as reported up to October 17, comprising 30 steel vessels of 60,156 tons, 7 iron of 2,981 tons, and 43 wood and composite of 30,578 tons.

The Sheffield Foundry Trade Technical Society had their second meeting last week, when Mr. R. Buchanan, a past president of the Institute of British Foundrymen, lectured on "The Foundry Cupola," illustrating his subject with views of British, Continental and American cupolas.

Sir Hugh Reid, Bart., was elected president of the Glasgow Association of Students of the Institution of Civil Engineers at the opening meeting of the session, held on November 22. Sir Hugh Reid, in his presidential address, dealt with the outstanding features of locomotive design as shown in modern practice. Thereafter a paper on "Puddle Trenches" was read by Mr. Oscar Manning, and a discussion followed.

Some time ago Kerr, Stuart & Company, Limited, were invited to form a company in India for the purpose of manufacturing railway locomotives. The directors of the company state that they have decided to accept the invitation after having fully considered and investigated the position. An undertaking known as the Peninsular Locomotive Company has been formed, the capital having been subscribed privately in India. The production of locomotives on an extensive scale is expected to begin shortly.

The secretary of Ewart & Collis, Limited, has sent to shareholders a letter containing an offer to purchase shares of the company. Holders are asked to advise the secretary on or before Monday, December 4, if they desire to accept or reject the offer. Subject to 90 per cent. in value of the preference shareholders and 75 per cent. in value of the ordinary shareholders, the buyers are prepared to purchase from each shareholder his shareholding in the company at 9s. per fully-paid preference share of £1 each and 3s. per fully-paid ordinary share of £1 each.

IRON AND STEEL MARKETS.

Pig-iron.

With the end of the current year now in sight the position in the pig-iron industry is hardly likely to undergo any material change, markets in the chief centres experiencing quiet conditions pending the stock-taking arrangements usual at these periods. In South Staffordshire better reports to hand of an expansion in the engineering departments has encouraged the demand for foundry pig, with the result that quotations keep very firm, while conditions are also improved in the case of forge iron. More of this quality is being sold, but, of course, the demand is very much below normal. The supporting influence of an improved inquiry is still backed up by the high price of coke, so that there is now little or no margin in prices, a fact which makes sellers rather disinclined to make forward contracts. It would be a great relief to see costs falling and the industry restored to a better and more profitable balance. Reports from Lancashire are couched in a more pessimistic strain than usual, although here foundry pig is a little firmer than previous quotations indicated. It is understood that the Lancashire ironfoundries have been getting more work lately, and the general belief is that the trade is not in such a bad condition as it was a few months back. The selling of Scotch pig-iron in this district has not altogether recovered from the effect of the high prices which were quoted during the period of American buying, but these prices here are now a little more reasonable. At Sheffield there is some quiet buying of foundry and basic iron, but the volume of business is rather smaller than of late. All makers, Lincolnshire and Derbyshire, are holding firmly to the quotations, and in some instances are asking slightly higher prices, but users show no great readiness to accept these. Conditions in the Cleveland iron trade continue somewhat inactive, the home demand having temporarily slackened off, and with prices showing a rather easier tendency consumers are disposed to adopt a waiting attitude. Fuel costs, however, are not coming down to any substantial extent, and until they do it is difficult to see how any further concession in pig-iron prices can be effected. Export business with the Continent continues to be handicapped by the exchange situation, and as regards America, there is nothing doing so far as ordinary foundry qualities are concerned. With regard to price movements, No. 1 and silicious, which have stood for a long time past at 97s. 6d., can be done at about 96s. 6d., and No. 3 G.M.B. is unchanged from last week at 92s., with No. 4 foundry 87s. 6d., and No. 4 forge about 82s. 6d. Mottled and white are negotiable at round about 80s. per ton.

In the East Coast hematite market the improvement in the finished steel trade is reflected in the demand, which is, if anything, rather stronger than last week. There is a fairly active inquiry, and substantial quantities are being sold to South Wales. Continental inquiry, too, is better, and moderate parcels are being shipped. The feeling all round is undoubtedly more buoyant, and recent quotations now certainly represent a minimum. East Coast mixed numbers stand at about 93s. to 93s. 6d. per ton, with the premium for No. 1 unchanged at 6d. to 1s. per ton. Messrs. Gjers, Mills & Company, Limited, and Messrs. the Seaton Carew Iron Company, Limited, are each putting in another furnace on hematite. Conditions in the Cumberland and North Lancashire hematite industry are also more active with prices firm, Bessemer mixed numbers being quoted at 110s. per ton delivered Glasgow or Sheffield.

Finished Iron.

The outlook in this section of the iron trade, though now regarded as much more satisfactory, is still largely dependent upon the early realisation of better conditions in the matter of costs of production and rail transport, which are to-day the principal factors hindering an expansion of business. Manufacturers are, however, fairly sanguine of a change for the better in the coming year, and meantime are experiencing a little more disposition on the part of buyers to entertain ideas of forward offers. It is at all events satisfactory to note some relaxation of the pressure of foreign competition in bar iron, due in a measure to the fact that Continental makers, having already booked substantial forward business, are no longer in a position to guarantee prompt deliveries of new orders. Naturally, under such circumstances, the Midland market is a little more cheerful, and nut and bolt bars are more steadily quoted at £9 15s., though possibly an attractive order would be accepted for rather less. Trade in crown bars is described as rather more regular, though there is still room for a big increase in the volume of demand before there will be any pressure. The top price obtainable is still £10 15s., and there has been nothing to make it more remunerative. Marked bars are quietly steady, while the outlook is regarded as a little more promising. The competition of steel keeps the iron strip trade most depressed.

Scrap.

As previously reported, the outstanding feature in the scrap metal markets of late has been the increased strength of heavy steel qualities and some revival of demand for foundry material. Both at Sheffield and South Wales the result has been a stiffening of prices for most descriptions of steel scrap. In the first-named market contracts up to about the middle of 1923 are offering, but sellers are not very desirous of accepting them at the prevailing prices, for it would cause little surprise if the material reached considerably higher figures before next year is far advanced, owing to the comparatively short supplies. At Middlesbrough, also, the scrap market is, on the whole, showing a more active tendency, particularly as regards heavy steel scrap, for which the demand appears to be steadily growing stronger. Prices have correspondingly hardened, and the general quotation is now around 70s. per ton. Steel turnings and cast-iron borings are also in good demand, and realise as much as 56s. per ton. Heavy cast-iron machinery scrap is still on the quiet side, but the quotation is firm at 72s. 6d. to 75s. per ton. There is a little more interest being taken in heavy wrought-iron scrap, piling material realising in the region of 67s. 6d. per ton, f.o.r., this district, with heavy forge 72s. 6d. to 75s. per ton. With the exception of piling scrap all quotations are delivered works.

Steel.

Although actual business in steel and its various products is at the moment still much below normal levels, the future prospects of the industry may be regarded as distinctly promising, some satisfactory contracts for new shipbuilding having already been placed, while the engineering and foundry branches may be confidently expected to benefit largely from the various schemes of railway and road constructional developments now under consideration to meet the unemployment emergency confronting Parliament. As regards semi-products, Sheffield makers report a more satisfactory demand, basic billets being bought with a good deal of freedom, and at last acid qualities are showing a more active condition. Quotations are unchanged. Business in most classes of steel is improving, and all round there is increasing confidence that the worst is over. The crucible steel trades continue to improve, electric steels not having yet replaced this section, as has been suggested by various interested parties from time to time. This improvement is interesting in that it is for carbon steels chiefly and not for high-speed steel. In the market for alloys, ferro-silicon is in only moderate request at the moment, and stocks are still fairly plentiful in all grades. Quotations are unchanged with most of the business passing done in 45 per cent. grade. A little business is still passing in briquetted ferro-silicon 80/90 per cent. Si., made from Government stocks of powdered silicon. The tinplate market is somewhat less active, but the demand is steady and prices firm. Although it might be possible to secure an offer at 19s. 6d. per standard box here and there, the general run of quotations is 3d. higher than the minimum.

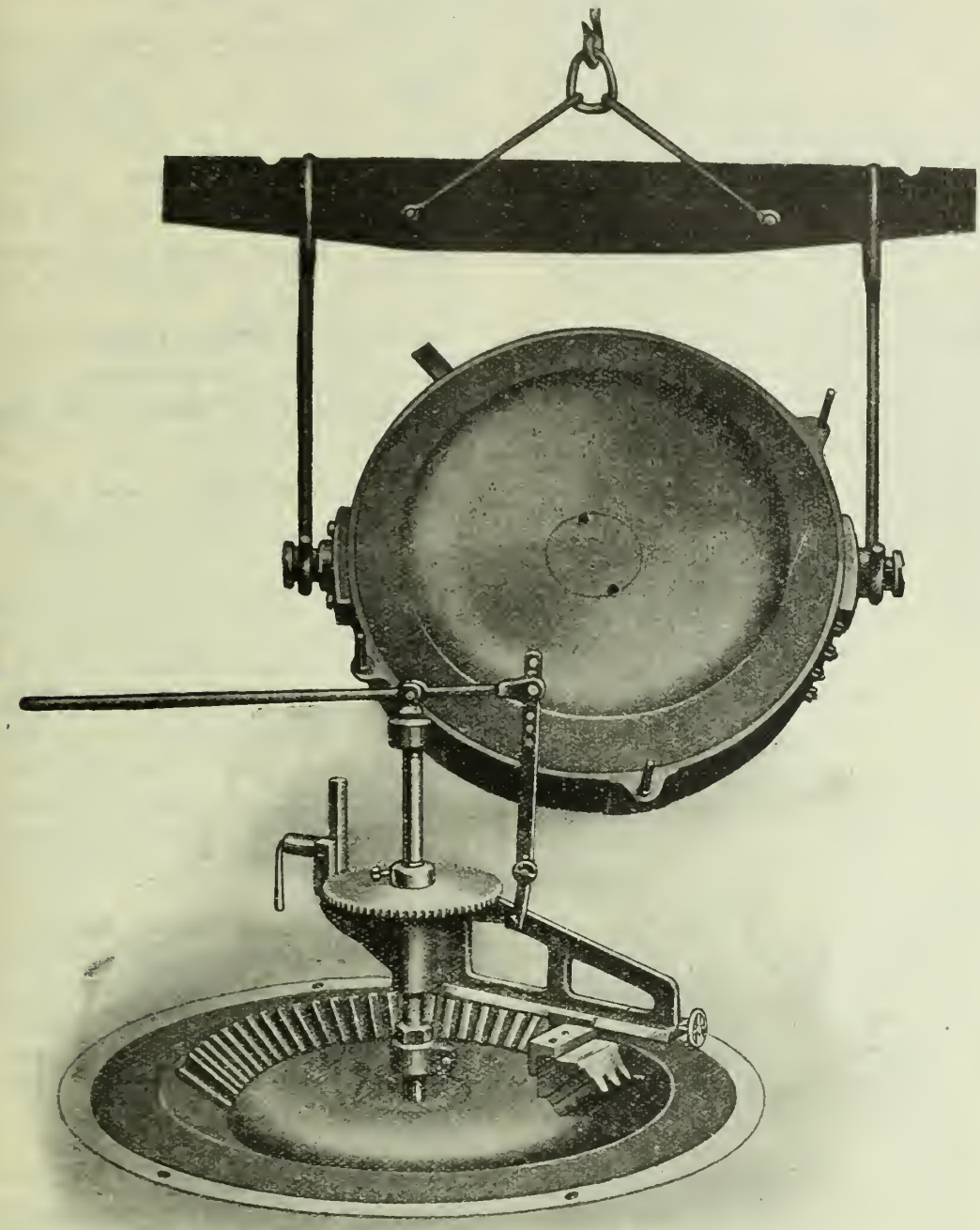
Metals.

Copper.—Business recently in the market for this metal has reverted to quieter conditions, and in the absence of speculative support dealings have been on a more restricted scale. Values of standard copper after a relapse made a slight recovery at the week-end, but have not yet regained the comparatively high levels obtaining in mid-November. In America the market for standard copper has been extremely quiet of late, and finally quotations are just the shade easier. This may be ascribed to the falling off of export demand, due to present political uncertainties, the wild movements in exchange, and particularly to the extraordinary fluctuations of the franc, which have checked buying on the part of French consumers. The ease in electrolytic, reflected on the market for standard copper, led to realisation of this description, with a resultant shrinkage in values. Current quotations:—*Cash*: Wednesday, £61 12s. 6d.; Thursday, £62; Friday, £62 5s.; Monday, £62 5s.; Tuesday, £62 5s. *Three Months*: Wednesday, £62 10s.; Thursday, £62 17s. 6d.; Friday, £63 2s. 6d.; Monday, £63 2s. 6d.; Tuesday, £63 2s. 6d.

(*Continued on page 478.*)

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.—*Continued.*

Tin.—Following the recent substantial relapse in values the market for standard tin has maintained a fairly level of quotations, with only slight fluctuations confined within a rather limited range. The chief reason for this weakness has been heavy liquidation and "bear" selling, induced by the changed aspect of the Eastern situation in regard to the disposal of the controlled surplus, which may easily take another year or so to accomplish instead of this surplus being released *en bloc*, as had been rather prematurely anticipated. Sentiment has been aggravated by the reported abnormally heavy Straits shipments for last month, estimated at about 6,000 tons. In the rather dislocated and uncertain state of the market America has largely abstained from further buying, although the sharp fall in our market has been to some extent counteracted by the rise in the dollar rate of sterling. Current quotations: — *Cash*: Wednesday, £174; Thursday, £174; Friday, £175; Monday, £174 5s.; Tuesday, £176. *Three Months*: Wednesday, £175; Thursday, £175 2s. 6d.; Friday, £176; Monday, £175 7s. 6d.; Tuesday, £177.

Spelter.—The market for this metal continues strong, with values again on the up-grade, corresponding with a similar tendency in America. The price of spelter there has broken sharply, and the break has been more than reflected on this side. Consumptive demand here completely died down on the fall, but in view of the statistical position of the metal we do not think that a revival of demand can be long delayed. Current quotations:—*Ordinary*: Wednesday, £39; Thursday, £39 5s.; Friday, £39 10s.; Monday, £39 10s.; Tuesday, £40.

Lead.—Consumptive demand during the past week has been a little quieter, but with supplies still restricted values of soft foreign pig have been well maintained. Current quotations: — *Soft foreign (prompt)*: Wednesday, £26 2s. 6d.; Thursday, £26 2s. 6d.; Friday, £26 2s. 6d.; Monday, £26 2s. 6d.; Tuesday, £26 2s. 6d.

Gazette.

Mr. W. H. Butt, 2, Wordsworth Terrace, trading as Hall Engineering Company, Lower Maiden Street, both Weymouth, engineer, has been adjudicated bankrupt.

Mr. F. C. Dowsett, 204, Goswell Road, E.C., engineer and toolmaker. R.O. November 21, has been adjudicated bankrupt. Examination Bankruptcy Court, March 14, at 11.

Mr. G. Richards, 14, West Bute Street, Bute Docks, Cardiff, iron and steel agent, has been adjudicated bankrupt. First meeting, 34, Park Place, Cardiff, December 11, at 11.

Hardy Construction Company, Limited, Manchester, engineers, in liquidation. Mr. G. R. Woollard, 5, John Dalton Street, Manchester, accountant, has been appointed receiver.

Trading under the style of Collett and Davis, Messrs. J. H. Collett and H. E. Sheldon, 72, Moseley Road, Birmingham, hearth furniture manufacturers, have dissolved partnership.

Messrs. T. M. Corbett, A. Corbett, and R. Gibson, coal cutting engineers, 38, Lennox Road, Hillsborough, Sheffield, trading under the style of Corbett Bros. & Gibson, have dissolved partnership.

Trading under the style of F. Brownsmith & Company, Messrs. C. H. Walters and F. W. Brownsmith, 14, New Street, Birmingham, metal merchants, have dissolved partnership. Debts by Mr. F. W. Brownsmith.

Messrs. W. C. M'Clelland & G. B. Burnside, trading under the style of Burnside & Company, 1,041, Argyle Street, Glasgow, engineers, have dissolved business. Debts by Mr. G. B. Burnside, who continues.

In the matter of the Hydraulic (L. A. C.) Trucks, Limited, a petition has been presented by J. Maddock & Company, Limited, Oakengates, malleable ironfounders. December 5. Agents, Willis & Willis, 59, Chancery Lane, E.C., solicitors.

Trading under the style of E. Bingham & Company, Messrs. E. C. Bingham, H. G. Bower and F. Leitch, Scottish Works, Allen Street, Sheffield, cutlery manufacturers, have dissolved partnership. Debts by E. C. Bingham and H. G. Bower, who continue the business.

The public examination took place at Walsall last Thursday (November 23) of William H. B. Troman and Henry Lee Tooth, trading as W. H. B. Troman & Company, 34, Booth Street, Wednesbury (Staffs), iron and steel merchants. The statement of affairs showed liabilities £413, and a deficiency of £411. The causes given for the failure were lack of capital, heavy trading expenses, including railway rates, salaries and hauling charges. The examination was adjourned until December 12.

Company News.

Joseph Tucker, Limited, Lichfield Chambers, 1, Leicester Street, Walsall.—Capital £2,500 in £1 shares. Ironfounders, etc.

Muta, Limited, 17, Farringdon Street, London, E.C.—Capital £3,000 in £1 shares. Directors: D. D. Walker and F. L. Dadd.

Onward Engineering Company, Limited, 178, Dock Street, Fleetwood.—Capital £2,000 in £1 shares. Directors: J. H. Wood and W. H. Littler.

Flinders, Limited, 121, High Street, Colchester.—Capital £500 in £1 shares. General Engineers. Directors: J. Warner, A. F. Hitchcock and M. C. Hitchcock.

Harrison Lee & Sons, Limited, 1, High Street, Limerick.—Capital £15,000, in £1 shares. Iron founders. Directors: R. N. Lee, Mrs. E. M. Nelson and J. Lee.

Marshall & Duguid, Limited.—Capital £5,000 in 4,000 ordinary and 1,000 preference shares of £1. Engineers. Directors: W. Easton, jun., R. S. Marshall and G. K. Johnston.

Lacey-Johnson & Company, Limited, 83, Victoria Street, London, S.W.1.—Capital £4,000 in £1 shares. Engineers. Directors: R. Lacey-Johnson, W. E. Riche, and W. D. Harding.

John Williams & Co. (Wishaw), 1922, Limited, Excelsior Iron Works, Wishaw.—Capital £30,000 in £1 shares. Iron, steel and coal merchants. Directors: F. Williams and A. H. Williams.

Marshall Electrical Company, Limited, 50, Marshall Street, London, W.1.—Capital £3,000, in 2,300 5 per cent. cumulative preference and 700 ordinary shares of £1. Directors: R. W. L. A. Ham (chairman) and W. N. Ibbotson.

Baldwins, Limited.—Settlement with Revenue authorities now made with exception of few matters still outstanding, and it is expected that annual meeting will be held not later than January 31, 1923. Declaration of dividend on ordinary for year passed.

Nineteen Nineteen Metal Company, Limited, 39, Corporation Street, Birmingham.—Capital £3,000 in £1 shares, to acquire the businesses now or formerly carried on by F. Mann, F. D. Longmore, and J. Gittens as the "Nineteen Nineteen Metal Company" at Birmingham, and Swan Village, West Bromwich.

Midland Iron Company, Limited.—Balance-sheet for 1921 and 1922 delayed in consequence company not yet settled with taxation authorities; trading operations for past year have resulted in loss; no dividend on ordinary shares, but preference dividend for year 1922 declared.

Bolckow, Vaughan & Company, Limited.—Debit, £85,369; brought forward, £203,507; balance after deducting loss, £118,138; interest on debentures, £80,000; dividend on preference, £23,604, leaving carried forward, £14,534; no dividend on ordinary shares; expenditure during year on colliery plants, steel works, etc., £355,113.

Personal.

Sir William Raeburn, M.P., has been re-elected chairman of the Clyde Trust.

The late Mr. J. P. Wirrick, lately manager of the Dudbridge Iron Works, Limited, Stroud, left £1,383.

Mr. E. G. Harcourt, managing director of Harcourts, Limited, brassfounders, Moseley Street, Birmingham, has retired.

The late Mr. Richard Moon, J.P., of Penyvoel House, Llanymynech, Oswestry, engineer, left estate of the gross value of £128,340, with net personalty £124,255.

Mr. W. J. Belsey, manager of the Glasgow branch of the British Thomson-Houston Company, Limited, has been appointed manager of the marine department at Rugby, being succeeded at Glasgow by Mr. J. Miller.

Mr. E. W. Leighton has resigned his position with the Mond Nickel Company, Limited, in order to devote the whole of his time to the affairs of the Anglo-Ural Platinum Trust Company, Limited, of which he is the managing director.

Mr. George Scoby Smith has resigned his position of commercial manager of Bolckow, Vaughan & Company, Limited. He has accepted the position of commercial superintendent, and the directors have elected him to a seat on the board.

Copper Alloy Pipe Fittings.—The British Engineering Standards Association, 28, Victoria Street, Westminster, S.W.1, has issued B.S. Specification No. 99, 1922, for copper-alloy pipe fittings, screwed for low and medium pressure British standard copper tubes (primarily for domestic and similar work).

THE

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Contents.

	PAGE
Rustless Iron and Steel	479
High or Low-Pressure Sand Blasting	480
International Exchange Papers	480
How Quality is Produced under Quantity Production Conditions	481
Italian Iron and Steel Industry	484
The Arbed Group	484
Dry Sand Moulding for Small Work	485
Catalogues Received	488
Influence of Temperature and Fatigue on Accident Rates	488
Gating, Feeding and Casting	489
German Iron and Steel Industry	490
Oxygen and Metallurgical Processes	490
Institution of British Foundrymen	491
Patent Specifications Accepted	492
An Apprenticeship Course in Foundry Practice.—XXII.	493
Some Tests for Foundry Sands and Their Practical Application	495
Moulding Sand Investigation	498
Zinc Industry of Northern France	498
Company News	499
Deaths	499
Gazette	499
Personal	499
Iron and Steel Markets	450
Trade Talk	402
Another International Foundry Trade Exhibition	452

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Rustless Iron and Steel.

An important contribution to the study of acid and rust resisting material was made in a Paper presented by MR. J. LONGDEN to the London Branch of the Institution of British Foundrymen last Thursday. The most important suggestion he enunciated was the manufacture of high-silicon alloys under such conditions that the control of the carbon could be more easily effected than is the case when cupola melted. Under such conditions it is possible that a better material may be produced, but it is not at all certain that a really important gain in strength would be produced, and its field would still be limited to its present applications and would not compete seriously with the field now occupied by the high chromium rustless iron.

We have previously put forward in this column the possibility of cupola melting a metal of the composition of chromium rustless iron, except for a high carbon, for the sake of the incorporation of relatively very cheap high carbon ferro-chrome and then decarbonising the castings made, by means of the Reaumur malleablising process. Since this time experiments on this line have been carried out, but it was found that the carbides of chromium were impossible of dissociation. The last issue of "Chemical and Metallurgical Engineering" to reach this country contains an account of some work carried out by Louis Jordan and F. E. Swindells under the auspices of the American Bureau of Standards, with the object of reducing the carbon in ferro-chromium by hydrogen. Experiments were made to ascertain the effect of heating ferro-chromium in an atmosphere of hydrogen at high temperatures. Certainly some reduction on what we presume to be the powdered form was found, but commercially the results were a failure. Experiments were continued by blowing hydrogen through molten ferro-chromium and a reduction of nearly 1 per cent. of carbon on an 8.4 per cent. original content. As the time of blowing was only four minutes, the process, if continued, might have shown good technical results, especially as they were confirmed by surface blowing for 20 minutes, which resulted in the same material having its carbon content lowered over 1.5 per cent. Again, however, we see small chance of the commercial exploitation of such a process. If success is to be achieved by any pneumatic system it is the Krupp patented process which appeals to us. This process is based on Bessemer's original idea of reducing carbon by blowing air through pig-iron, the modification being that cheap or high-carbon ferro-chrome is melted and blown with the production of the dear or carbon-free material. From experiments which we have conducted, we have found that there is a very considerable loss of chromium. The electric furnace, too, presents a useful experimental plant, using iron- or chromium-ore as an oxidising medium for the carbon, but when working with ferro-chromium an equilibrium appears to be set up about 2 per cent., beyond which it is difficult to go. Again, when working with steel scrap and high carbon ferro-chromium which gave a 2 per cent. carbon content in the bath, the oxidation process proceeded satisfactorily until the carbon had been reduced to 0.5 per cent. Here an equilibrium was set up with which was impossible to break down, and the material had to be teemed and remelted, when no difficulty was experienced in arriving at 0.28 per cent. carbon. We believe that other trials have been successfully made by using chromium ores instead of iron ores. The problems of making rustless iron or steel without using carbon-free ferro-chromium or by making this material cheaply from low-grade alloys are metallurgically fascinating. Especially so is the latter, as one has more than £50 per ton with which to cover manufacturing costs before the difference in market value of the cheapest and dearest disappears. Foundrymen must realise that this subject is not wholly for the ingot manufacturer, as castings are being made in this rustless material. Efforts are being made to cast propellers in rustless steel, and if the largest sizes are to be made, then an effort to utilise low-grade ferro-chrome assumes the highest importance.

High or Low-Pressure Sand Blasting.

Some little time ago the balance of foundry opinion was in favour of high-pressure sand blasting, as figures were produced showing that more metal was removed per given horse-power employed. However, the latest advices from the States seem to indicate that the pendulum is now swinging back again to lower pressures. Messrs. Tilghman's Patent Sand Blast Company, Limited, of Broadheath, have recently published a statement on this subject, which presents considerable interest for foundrymen. The brochure points out that factors necessary to be studied are the actual economy of the sand-blast machine itself, the cost of the compressed air used, and sand worn out by the machine, and the amount of sand-blast power that can be conveniently put into the hands of one man so as to reduce the wage cost of the operation.

Sand Impact Proportional to Necessary Work.

One pressure of air is not the most economical for all uses. The grain of sand must deliver a blow of a force properly proportioned to the work that it is expected to do. A given horse-power of compressed air will impart a certain velocity to a given weight of sand per minute and no more. If this velocity is sufficient, then doubling the velocity of the sand will reduce the factor of economy of the machine to 25 per cent. of its former efficiency for these reasons. At double the velocity, each grain of the flying sand will contain four times the energy as the same grain at the lower velocity. The total quantity of sand to which it can impart this velocity, therefore, will be only one-quarter that to which it can impart the lower velocity. As at the lower velocity, the sand has sufficient energy to do the work required of it; with greater energy it can do no more, and the extra energy imparted to it is only wasted.

Additionally, there are other sources of waste; for instance, there is more "slip" between the sand and the impelling air at higher than lower velocities. At lower velocities the comparatively lower pressure air imparts more nearly its own velocity to the sand than does the higher pressure air moving at a greater velocity. This can readily be appreciated by the fact that at the lower pressures, say at about 10 to 16 lbs. per sq. in., when the machine is running without sand, when the sand is turned on, the pressure will be found to rise from 25 to 30 per cent., or to 14 to 20 lbs. per sq. in. Whereas when the machine is running at about 80 lbs. to the sq. in., the rise of pressure is scarcely perceptible, not over 2 or 3 per cent., when the sand is turned on. In no other kind of machine would a machine that consumed 97 per cent. of its power load when running empty be put forward as an economical machine. These conclusions were the cause of the low- or moderate-pressure machine being developed, and a long course of comparative experiments fully verified them.

Pressure and Hose Pipe.

These conclusions are true of any type of sand-blast machine, but with the flexible hose type of machine they are still more intensified for the following reasons:—

In any event, the long flexible hose is source of loss of power for the obvious reason that every time a grain of sand strikes the soft elastic lining of the hose it loses a very considerable portion of its velocity and drops back into the current at a reduced velocity, which must be again imparted to it if it is not to drop and, by a repetition of the process, finally come to rest and clog up the tube. For this reason, the larger the diameter of the hose, and the less velocity of the mixed stream of sand and air passing through it, the less is this loss, for the reason that the larger the hose, the greater the ratio of its cross-section to the area of its walls; and therefore the fewer are the impacts of the sand grains passing through it with its walls, and also owing to the low velocity, the less is the loss at each such impact. As an illustration, in a low-pressure machine a hose 2½ in. internal dia. passes 180 cub. ft. of free air compressed to 14 lbs. per sq. in. per min.

When the sand is turned on, this air carries with it about 35 lbs. of sand per min., and the pressure rises in discharging the same amount to about 20 lbs. per sq. in. This mixed stream is discharged through a ⅝-in. nozzle. With a "high-pressure" machine having a hose ¾ in. dia. it carries an unspecified amount of air at 80 lbs. per sq. in., and discharges it through a nozzle 3-16 in. dia. The increase of pressure, when carrying sand, would be practically imperceptible, and the amount carried could not possibly be more than 6 or 8 lbs. per min., probably much less. This forced through a tube of only 0.09, the area of the low-pressure hose width, it is easy to see what a loss of velocity and wear on the tube from the fact that the machine will not work at all if the pressure is reduced very much below the specified 80 lbs. per sq. in. When discharged, the sand has not to exceed an efficiency, weight for weight, of more than 1¼ to, at most, 1½ that of an equal weight of sand discharged from the low-pressure machine, or a net cleaning power of, at most, one-third that of the latter machine at the same cost of air and a greatly increased cost for sand and hose, which the higher pressure wears out much more rapidly, and at a wage cost, if in each case one man handles one hose, of three times that called for by the low-pressure machine. Including wages, air, sand and hose, this type of machine will cost nearly or quite six times as much per sq. ft. of cleaning ordinary castings, forgings, etc., than the L.P. machine.

Another aspect which illustrates the inherent waste of the former class is as follows:—The air that is discharged at a considerable velocity from the nozzles of either class of machine is itself of considerable weight, namely, about one-thirteenth of a pound for each cub. ft. of free air before compression. Taking the machine discharging 180 cub. ft. of free air per min., this air will weigh about 14 lbs. It is discharged at practically the same velocity as the sand with which it is mixed. The force necessary to give velocity to the air is in itself without effect in sand blasting. Only the force which is imparted to the sand is useful. It is therefore self-evident that a machine which discharges a mixture of 14 lbs. of air and 35 lbs. of sand per min. transforms somewhat over 70 per cent. to the total force put into it in giving useful velocity to the sand it discharges, and wastes only somewhat less than 30 per cent. in incidentally imparting velocity to the air that is discharged along with it. Whereas a machine that discharges the same weight of free air per min. at the higher pressure mixed with only 6 to 8 lbs. of sand at a maximum utilises only 30 to 35 per cent. of the force in usefully throwing sand, and wastes some 65 to 70 per cent. of its force in uselessly throwing air at the same velocity. This is to say nothing of the fact mentioned above that, at the higher pressures, the sand does not so nearly get the same velocity as the air in which it is mixed and propelled as it does at a lower pressure.

Nozzle Considerations.

Another wasteful point of the high-pressure machine is the fact that it often uses a very short nozzle. It is evident that the higher the pressure and the greater the velocity sought to be imparted to the sand, the longer should be the nozzle through which the mixture passes, so that the air will have a longer time to act on the sand. The reason that this is not done is that, at the higher velocities, the wear of the flying sand is so destructive to the nozzles as to be more expensive, and therefore recourse is had to a short nozzle, thereby sacrificing economy and efficiency of action to secure a longer life to this part of the machine.

There still remains to be dealt with the question of the removal of the dust from the used sand and its re-use, and with the question is connected the conveying of the sand to the storage hoppers.

International Exchange Papers.

At a meeting of the General Council of the Institution of British Foundrymen, held at York last Saturday, it was decided that Dr. Percy Longmuir, Director of Research to the British Cast Iron Research Association, should present a Paper on their behalf. It was also announced that Major R. A. Bull, of the American Steel Founders' Research Group, would present a Paper on behalf of the American Foundrymen's Association to the Manchester Conference.

How Quality is Produced under Quantity Production Conditions.

By H. Cole Estep (European Manager of "The Foundry").

(*Continued from page* 469.)

American Basis for Management.

This system of control begins in the foundry with the appointment of a man of the broadest possible foundry knowledge and experience to the position of foundry manager, making him responsible only to the works manager or general manager as the case may be. In other words, he should be co-ordinate in salary and responsibility with the man in charge of the machine shop. Depending on the size of the shop, he should have a varying number of lieutenants in charge of the several foundry departments, such as the melting, moulding, core making, cleaning, etc., including the pattern making. A metallurgical chemist, capable of doing not only routine, but research work, is essential; on him rests the chief burden of obtaining a metal of the proper quality. In a large shop, a millwright's department is also necessary for keeping the machinery in order. The inspection and testing department is preferably independent of the foundry superintendent. If the plant is large enough, the several department heads are assisted by under-foremen and charge hands, as required. They must all be thorough foundrymen, and men of some culture and general education as well. They must be possessed of the temperament, tact, and firm judgment which go with leadership. On all these men rests a heavy burden of responsibility, for the rank and file have only limited intelligence and training. Accordingly, such men are well paid, and it is not uncommon for the general superintendent of an American foundry to draw a salary of £1,600 a year, with his chief lieutenants receiving from £700 to £1,200. Naturally there must be a large output over which to spread such a pay roll, and the strain on the leading men is correspondingly nerve-wracking and severe.

Some further detail regarding the production expected and attained under these conditions will now be presented, accompanied by an explanation of the methods adopted and results obtained, thus bringing the subject to its crux, which is to show with some definiteness the steps taken in large American foundries to control the quality of the product.

Where Quality Commences.

The control of quality in a foundry commences with the cupola or melting furnace, but since good metal is useless without good moulds into which to pour it, the latter will be considered first.

A most striking example of increased efficiency, accompanying increased production, was recently reported to the writer by M. A. Blakey, now foundry engineer for the International Harvester Company. In making automobile engines, the crank-case core is usually rammed up in two halves, which are subsequently pasted together. These cores must be very accurate, and it has been customary to rub down the joint of the core by hand to ensure a satisfactory casting. The production under these conditions was approximately 10 half-cores per man per hour. When at the Wilson Foundry and Machine Company, Mr. Blakey says, a machine was built to finish the joint between the two halves of this core by grinding. Two men with this equipment actually turned out regularly 125 half-cores per man per hour, compared with 10 by the preceding method. The hand-jointed cores varied from piece to piece by as much as 3/32 in., whilst the machine-made cores never varied more than 1/64 in. By hand, the quality of the product depended on the workman, whereas under the mechanical method it depended solely on the set-up of the machine, which had to be checked only at intervals of three or four days.

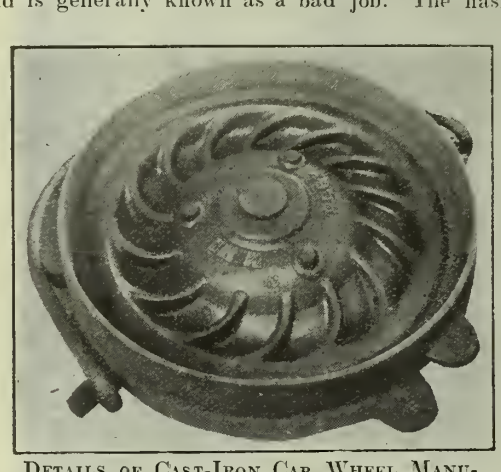
In another case, mentioned by Mr. Blakey, on the testing bench where the cylinder blocks for Buick cars were subjected to water pressure before delivery to the machine shop, men working by hand each tested 14 sets of cylinders per hour. The holes were closed with clamping pads and expanding plugs. After becoming worn, the plugs would occasionally blow out, drenching the operator, who, when not under the eyes of the foreman, became inclined to reduce the water pressure. This resulted in some leaky cylinder blocks finding their way into the machine shop, with

Details of C. I. Car Wheel Manufacture. A Drag Section is shown with the Cores Set and Another being Turned Over.

generally deleterious effects on the quality of the output of the foundry. Later, a semi-automatic test-rig was provided, which stopped all the holes securely and made it impossible for the operator to reduce the water pressure. This device was operated by one man, who was thus enabled to handle 75 cylinder sets per hour. Three men were released for other work, but, what was more important, the substitution of an accurate machine for human frailty not only speeded up production, but materially improved the general quality of the castings manufactured.

The importance of constantly studying details of shop procedure, in order to control and improve the quality of the product, was clearly brought out some little time ago by Joseph J. Wilson, plant manager of the General Motors Company, in an address before the National Founders' Association in New York. Speaking directly on the posibility of improving the quality of moulds, and consequently castings, by the adoption of mechanical methods in place of so-called skilled hand labour, Mr. Wilson said:—

"By studying the peculiarities of machine-rammed moulds, and then designing our flasks accordingly, we have been able to eliminate completely all gaggers from our production work. I will give an actual example. We received a job, patterns, flasks and machines, which had been running at an outside foundry for about two years, and is generally known as a bad job. The flasks



Details of Cast-Iron Car Wheel Manufacture—A Pattern is shown in the Chiller. The Dot on the Pattern Must Correspond to the Line on the Chiller.

were good cast-iron flasks with machined joints, and the customary number of bars. It required 78 gaggers and 42 twentypenny spikes for each mould. We designed a new flask, which resulted in the elimination of all the gaggers and a reduction of the number of spikes and nails to eight for both the cope and drag. We also were able to discontinue tucking the bars. This made it possible for any labourer who can shovel sand to operate the machine and give us a perfect mould. What was considered a bad proposition had become a good job, with a loss of under 10 per cent. instead of the previous loss of 40 to 60 per cent. This is the only job on which we are using nails, although our work is all of a more or less intricate and irregular shape, and our sand has to be kept fairly weak in order to run our thin section work."

Getting the Right Sand

To operate successfully on the quantity-production basis, special attention must be given to the handling of materials, especially pig-iron and sand. Mr. Wilson points out that one crane operator and one labourer can unload 40 tons of pig-iron with a magnet in an average time of 45 min.. This estimate takes into consideration transferring the metal a distance of 50 ft. To do the same work by hand would require at least 15 men. "A modern installation for mixing facing sand," says Mr. Wilson, "may vary from a plain power riddle to a combination of a riddle, a crusher, and a centrifugal machine. At the Central foundry the batch is made up in front of the riddle located on the floor level, the sand being shovelled into the riddle by hand. A short bucket elevator raises the sand from the riddle to the crushing mill, in which the mixture is thoroughly ground. Another short elevator raises it to the top of the centrifugal mixer, which discharges directly into bins below. The capacity of one of these units is 158 tons per nine hours of continuous operation. A crew of three men making up the batches and running the machinery intermittently can mix about 46 tons of facing per day." Core sand may be handled along similar lines. This system means that the sand is mixed at minimum expense per ton, with the added advantage that, given proper supervision, it is absolutely uniform from day to day, resulting in more satisfactory castings than where the moulders are allowed to mix their own sand, according to their own fancies or ideas.

Few foundrymen appreciate the weight of material handled in their shops per unit of output. A study of this question shows how necessary it is to give thought to the details of production. Along this line, Mr. Wilson said in the address already referred to, that at the Buick foundry it was found that it was necessary to handle over 64 tons of material for every ton of finished castings produced, in spite of the fact that the plant is laid out so that a continuous flow of materials is possible.

"In order to save floor space and flask equipment at the Central foundry," said Mr. Wilson, "the shop is run continuously— that is, the pouring starts at 7 o'clock in the morning, and the bottom is dropped at 4.30 p.m. After giving the matter considerable thought, it was decided to set the moulding machines in the middle of the floor, instead of at one side as is customary. The operators start in the morning on one side of the machines, and after placing about 24 moulds, varying with the size of the job, they move to the other side. Then, while they fill up this space, the moulds on the side first filled are poured and shaken out, and the sand is tempered and cut back to the machine with a travelling sand-cutter. By this method 120 to 140 moulds, each 24 × 36 in., of a four-cylinder block with the crank case attached can be moulded on a floor 24 × 60 ft. in a day. This same floor space will also produce 100 to 110 six-cylinder blocks, each of these floors requiring an equipment of only 40 flasks. For jobs such as crank-cases, requiring little core setting, which at the same time are quick cooling, a production of 200 to 225 moulds requires a floor space of 960 sq. ft. Six hundred and thirty 12 × 18 in. snap-moulds have been produced on a floor space of 480 sq. ft."

At the Ferro Machine & Foundry Company plant at Cleveland, with methods akin to those just described, but using continuous conveyors, as high as 58 good Chevrolet cylinder-castings an hour are being made.

These high-production methods are not confined to the motor-car industry, although it is in that field that they have reached their greatest development. For the new vehicular tunnels under the Hudson River 88,140 segment castings will be required, with an aggregate weight of 115,000 tons. Although made wholesale, these castings must conform to the most rigid specifications. The composition of the metal is as follows:—Si., 2.50 per cent.; S., under 0.05 per cent.; P., 1.00 per cent.; and Mn., 0.70 per cent. These castings are to be produced at the rate of 200 tons a day on large jolt-ram roll-over moulding machines using a large number of accurately fitted interchangeable flasks. The core-prints are attached permanently to the pattern, and the end-cores, which are of an odd size, are grouped on one large core; thus the chances for error are eliminated, and the cores can be set with perfect accuracy by unskilled labour.

Cast-Iron Car Wheels.

American railway truck wheels, which are of cast iron with a chilled tread, offer another example of a combination of rigid specifications and quantity production. Two hundred wheels a day may be regarded as the average output of a "car-wheel" foundry. This necessitates melting about 100 tons of iron a day and handling an immense tonnage of sand, flasks, etc. In most modern car wheel foundries, the moulds are arranged in long, straight rows, each row being under a monorail hoist which serves to handle the flasks and molten iron. The moulder is relieved of virtually all

responsibility. He rams the sand, draws the pattern and sets the cores. He has to do no measuring; chaplets are supplied of the exact length, and are attached to permanent locations in the flask bars. Two men put up from 20 to 24 car wheels a day. The wheels weigh from 550 to 750 lbs. each. Their average life is about 60,000 miles. They must conform to the most rigid tests and specifications, since breakage might easily result in a disastrous wreck. In fact, only a fraction of a per cent. of these wheels break in service, although the loads are frequently 10 tons per wheel.

Machine Tool Foundries.

Foundries catering to the machine-tool trade must also meet closely-drawn specifications, and at the same time get out a large tonnage. In a foundry taken over by the Bullard Machine Tool Company, Bridgeport, Conn., the average daily output of castings per man was raised from 350 to 1,180 lbs. through the application of intensive production methods, coupled with a plan of paying wages which provides a bonus in addition to the hourly rates for increased production over specifications for medium castings call for a tensile strength of 9 tons per sq. in. and a transverse strength on the arbitration bar of 2,900 lbs. per sq. in. At the Bullard plant, however, the average tensile strength is 14½ tons and the transverse strength around 3,960 lbs.

Beds for 24-in. vertical turret lathes conforming to these specifications are now moulded in 14 hrs., as against 28 hrs. before machine equipment was installed. The bed for a 36-in. vertical turret lathe, which formerly took 32 to 34 hours to mould, is now turned out in 16 hrs., while a 42-in. bed, formerly taking 42 hrs., is now made in 24 to 26 hrs. The best time under the old system for the bed of a 61-in. boring mill was 56 hrs. This work is now accomplished in 32 hrs.

Where the Catch Comes.

Many are the devices which the progressive manager of an American quantity production foundry develops solely for the purpose of protecting the quality of his output. This gentleman is pictured in the minds of some people as spending his days and nights exclusively on contrivances

In this Foundry, a Magnet Suspended from the Crane is Employed to Make up the Pig-iron Charges in the Steel Buckets. Each Bucket Holds 10,000 lbs.

a predetermined standard. Quality standards cannot be maintained under any system of quantity production which does not provide good wages. In fact, in the most successful quantity production shops, where the highest grades of work are turned out, the men earn considerably more than they could obtain for similar work in most other shops. But since these high earnings are spread over an increased output, the wages per ton are usually less than the average. Thus in one Detroit shop girl coremakers are earning about £1 a day, but through supplying mechanical equipment, which reduced the maximum lift to 30 lbs. weight, the production was increased 25 to 75 per cent., and the core-making cost reduced as much as 50 per cent., despite the high wages.

At the Bullard foundry, mentioned above, the average output recently has not fallen under 1,020 lbs. of good castings per man per day, with a maximum in one week of 1,360 lbs. per day. This is on lathe beds, head stocks and other machine-tool castings. Tests have shown that owing to the use of proper equipment and careful supervision this rate of production has not brought about any deterioration in the quality of the castings, which conform to high standards.

The American Society for Testing Materials'

and schemes to squeeze a little more effort out of the workmen, or in urging an already over-taxed equipment to just a trifle higher speed in order that the precious tonnage chart may trend ever upward. Intriguing as this picture may be to the disciples of easy-going methods, it does not reflect the facts. The modern foundry manager really devotes most of his thought to problems relating to the quality of his product, and to meeting specifications, while at the same time keeping up a predetermined rate of production. Once the proper rigging is set up and put in motion, it is easy enough to turn out a thousand automobile cylinder blocks a day. If this is all that were required no high-priced foundry managers would be necessary. Where the catch comes is in turning out a thousand *first-class* cylinder blocks a day. It is for doing this that the foundry manager draws his high salary. The writer knows of one shop in Detroit where, as soon as each mould is made, a sheet of clean white note-paper is placed over the runner to prevent any small particles of dirt from being brushed into the cavity. Very likely the resulting castings would be just as good if this detail were omitted, but these clean sheets of paper serve to remind every man in the shop of the necessity for taking care. They symbolise the ideals of the

management, which are focussed not on merely out the work, but on getting it out *right*. And in working toward this end the psychological value of these sheets of paper is considerable. They aid definitely in getting out a better grade of castings.

But the struggle for quality in the foundry is handicapped by the fact that, in most directions, it is not possible to work objectively. The real worth of a casting depends in the last analysis on the hidden action of the melting furnace and on invisible elements in the metal mixture which determine the strength, elasticity and resistance to wear of the final product. Therefore, in a properly-run quantity-production shop the metallurgical department is of paramount importance. Results are what count, and results depend on the metal. Chemical control of melting practice, coupled with patient research into metallurgical mysteries, are almost invariably found in American foundries of the better sort.

Analysis at the Spout.

One foundry making soil pipes on a large scale is able to maintain high standards along with the production of 300 tons per day, according to George K. Elliott, of the Lukenheimer Company, Cincinnati, by having a chemical laboratory situated right at the cupolas analysing every ladle of iron individually, including determinations for carbon. This continuous analytical control makes it possible to detect immediately any tendency to diverge from the predetermined standards of quality, these divergencies being corrected before they have become serious.

(To be continued.)

Italian Iron and Steel Industry.

A Ministerial change that brought into power men of action gave new energy to the Italian iron and steel industry, and the shares of many of the works improved. A proposition was made in the Italian Parliament for transferring some of the railways to private companies, with a view of stopping some of the present abuses, and seeret negotiations were opened with a small group of financial and industrial people.

Although other metals went back in price considerably, due to the improved foreign exchange, this was not the case with iron and steel, the prices of which changed very little during the month. After long negotiations with Franee, Italy made an agreement for a year, under which minimum tariffs were arranged on imports from both countries. This will undoubtedly favour the importation of coal, pig-iron and scrap from France, already facilitated by the improved exchange.

At the time of writing no decision has as yet been arrived at by the Government regarding the embargo to be placed on the export of scrap metals, and for this reason Italian works continued to suffer a certain seareity of same, being thus less favourably situated than the German works, who continued to compete with them in their own market. The newly-formed firms of Ansaldo, Terni and Ilva, although still in the throes of consolidating their position, have been able to increase somewhat their production.

Some of the quotations on the Milan market at the end of November were as under, in Lire per metric ton (exchange rate about Lire 94.50 to the £ sterling): Black sheets (4 mm.), remained at 1,750 (£18 10s.); galvanised sheets (No. 20), remained at 2,950 (£31 4s.); black wire remained at 2,050 (£21 14s.); rods remained at 1,500 (£15 16s.); cast-iron pipes remained at 1,950 (£20 13s.); boiler tubes remained at 3,500 (£37 1s.); Italian welded tubes remained at 2,900 (£30 14s.); Italian seamless tubes remained at 3,100 (£32 16s.); Italian galvanised tubes rose from 3,750 to 3,800 (£40 4s.); railway rails fell from 1,350 to 1,300 (£13 15s.).

Wm. Olsen, Limited, inform us that they have removed their office recently from 74, Cogan Street, to the corner of Cogan Street and Spruce Street, Hull. The premises at 74 are now used only for stores, and correspondence should in future be addressed to William Olsen, Limited, Cogan Street, Hull.

The Turbine Furnace Company, Limited, received eleven orders during last month for their patent furnace to be fitted to various types of boilers. Many were repeat orders, including those from Richard Thomas & Company, Limited, the South Metropolitan Gas Company, and the Hughes Stubbs Metal Company.

The Arbed Group.

The annual meeting of the Aciéries Réunies de Burbach-Eich-Dudelange (Arbed) was held on November 25, in the new premises in Luxemburg, when the report and accounts for 1921-22 were received and approved.

The report states that the crisis referred to in the previous report particularly affected the early months of the past financial year, and the improvement which subsequently set in was very slow. It was due mainly to a considerable increase in the output, which it had been found possible to dispose of without difficulty, thanks to the Company's commercial organisation on the one hand, and their investments in foreign industrial undertakings on the other hand, which absorbed increasing quantities of the Arbed's products. At present the situation could be regarded as comparatively satisfactory. Future development would depend essentially on political events and the solving of the problem of reparations. During the year no special difficulties were experienced in obtaining fuel supplies, so that it was possible to increase the output and earn nearly the same profits as in 1920-21. After referring to the burdens imposed by the legislation of the Grand Duchy and to the freedom from labour troubles during the year, the report states that the Company had decided to allocate to the social welfare fund the sum of 4,500,000 fcs., being the same amount as in 1920-21.

The Comptoir Métallurgique Luxembourgeois (Columeta), which was established two years ago in conjunction with the Société Métallurgique des Terres Rouges for the sale of their products, continued to give complete satisfaction. Since the preceding year new branches of the Columeta had been established at Antwerp, Stuttgart, Sofia, Shanghai, Hong Kong and Tientsin. Concerning the associated undertaking just referred to—the Terres Rouges—the report mentions that the second year of the latter, as had been fully expected, turned out less favourable than the first year. Nevertheless the situation was markedly better than in 1920-1, particularly in regard to the Luxemburg branch at Belval. The report refers also briefly to other undertakings in which a financial interest is held by the Arbed, and then proceeds to give figures of the Company's production in 1921-22.

The output of the iron mines amounted to 1,748,000 tons (1,575,000 tons in 1920-21); the coke output at Burbach was 297,000 tons (204,000 tons); of pig-iron, 730,000 tons (482,000 tons); of basic and open-hearth steel ingots, 735,000 tons (498,000 tons); of electric steel, 219 tons (299 tons); and of rolled products, 621,000 tons (416,000 tons). In addition, the shops producing structural work turned out 6,621 tons, as against 3,487 tons in the previous year. The total number of workmen employed by the concern was 14,461, and the officials numbered a further 768.

The gross profits amount to 28,152,000 fcs., as compared with 30,253,000 fcs. in 1920-21. After writing off 8,219,000 fcs. for depreciation and appropriating 4,500,000 fcs. for welfare purposes, the accounts show net profits amounting to 15,432,000 fcs., and the proposed dividend is at the rate of 120 fcs. per share, as in 1920-21.

Grangesberg Company's Shipments of Ore.—Shipments of iron ore by the Grängesberg Company during the first ten months of the current year amounted to 3,979,000 tons, as compared with 2,995,000 tons for the same period in 1921.

Forges et Aciéries du Nord et de l'Est.—This French concern reports for 1921-22 net profits amounting to 690,936 fcs., which, added to the sum brought forward from the previous year amounts to 1,986,125 fcs. (say £33,100) which is to be carried forward to next year's account.

Forges et Aciéries de la Marine et d'Homecourt.—This French concern reports for the financial year 1921-22 net profits amounting to 3,693,521 fcs. (say £61,560). The dividend is to be 30 fcs. per 500-fc. share, as against 40 fcs. in the previous year, on a share capital of 70,000,000 fcs. in both years. The Board suggests an increase in the share capital.

Dry Sand Moulding for Small Work.*

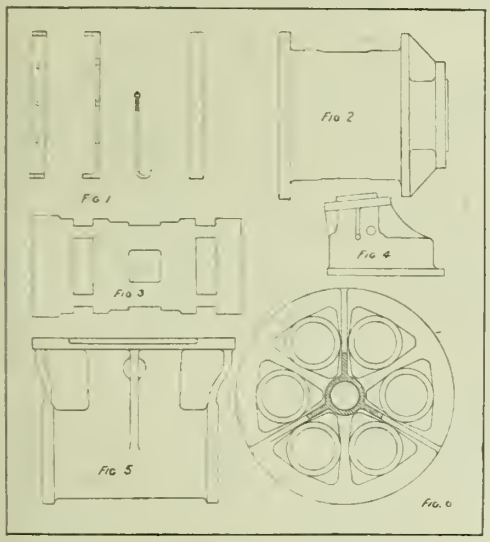
By J. D. Nicholson, A.I.Brit.F.

Small work in dry sand moulds is generally regarded as the simplest of the various classes into which the founding of castings is divided, and is distinctly a class by itself. Like its companion class, green sand, the same amount of care is needed, and although the sand ingredients are somewhat similar they are compounded and used in an entirely different manner.

Dry sand being glutinous, earthy and highly refractory—entirely opposite to the quality required for green-sand—it must be worked with a certain degree of dampness to bring that cohesiveness, plasticity and pile which it readily gives.

Heavy and large castings are moulded on different lines from small castings. A small-work moulder would very readily adapt himself to the methods and conditions of making large castings, but when reversed results satisfactory to the employer are very seldom obtained. It takes a man a long time to master this class of work, and it is only by being alert to the circumstances, and the use of commonsense that he is able to find out the methods of moulding intricate and troublesome parts, and also to remedy any little fault in the patterns, as well as in the castings.

Over-confidence in the strength of the sand or omitting an iron during ramming may mean a few



hours' anxiety during finishing the mould, and even the result will not be certain until the dressers have finished with the casting. A joint may be made correctly to suit the pattern, and yet be wrong in regard to fitting the cores in the mould. The leaving-in of a screw in large patterns—sometimes the impression is received that the patternmaker does his best to hide important screws—can be remedied by the application of weight and pressure, but not so in small work, where this fault may be the reason for the mould having to be made over again. The gathering together and working with several odd part boxes calls for careful manipulation, as also does the placing of runners and risers, and making passages for core-vents.

A moulder should have a knowledge of the various types of machinery which his firm builds. He then knows which is the important part of his casting, what part *must* be sound, and also where to allow for machining instead of continually referring to his foreman, as every pattern is not marked as to where the casting has to be machined. He would know where the placing of a chaplet would be detrimental to the casting, and why the pattern had been made in such a way. He should be able to see all his requirements from deciding upon the boxes to be used, to the position of the weight for casting.

The moulder might also pay attention to the manner the cores are being made. A good mould is as essential to a good casting as a good iron. Cleanliness, individuality and speed, combined with care, are qualities which a small-work moulder must possess.

The castings made by the dry-sand method are usually those of intricate design which would entail a certain amount of risk if made in green sand; outstanding amongst these are castings which have to be scrupulously clean when machined and others having to withstand a high steam- or water-test.

Boxes and Bars.

Owing to the continual change of designs in various branches of engineering and regular slight additions to patterns, it is very desirable that boxes should be available which can take loose bars. A good supply of boxes of several different sizes should be at hand, as well as an ample quantity of loose bars. Each box should have numerous holes in its side to allow for bars being inserted, and also a few, about 2 in. dia., to assist drying and also for passages for core vents. Fig. 1 illustrates typical bars. A supply of hook bolts, up to 16 in. long, are very handy as box bars. In such places as where two pieces of pattern are near each other, say about 2 or 3 in. apart, it would be impossible to fix an ordinary bar, and some moulders would have recourse to laying long irons over this part, which have no definite hold save the binding of the sand. If, however, hook bolts are passed under, and screwed up, they answer the purpose with good effect. For instance, underneath the flange of a branch in a top part, a good workman would foresee it and move his box to suit. In all cases, where bars suitable for bolting are not to be had, bolts of this description are far more easily inserted and safer as compared to the proverbial wedging in of loose bars. This wedging-in, especially if two or three bars have to be inserted, often takes up much time, besides causing annoyance, but still it is a fairly simple and quick matter if the hammer is used with intelligence. There is no strain on the box when bolted, bars or long bolts are used, whereas the wedging-in of bars often fully extends the box side, resulting in the box being broken during the operation of removing the casting—the least tap with a hammer on the side of the warm box being sufficient. Of course, wooden bars can be adapted in dry-sand moulding, but they must be used with discretion, and in a top part the sand must be stayed-down previous to casting.

In making a mould, there are often doubts as to whether it should be moulded in the floor or in boxes to be dried in a stove. Even if it were only for the comfort of the employees, the latter method should be used whenever possible, and perhaps also it would show a saving in the coke bill.

Turnover Moulding Preferable.

Wherever it is practicable, in small work, patterns should be turned over instead of bedding in the floor. It would materially lengthen the life of the pattern, as it would suffer less from heavy impacts. The moulder would see better in place of working "blind," as sometimes occurs when moulding in the floor.

In digging a hole in the floor to mould a pattern, it is the custom to sprinkle water over the hole. Sometimes a great deal is used to soften the sand, so that the new sand will adhere to the old, and if a casting has been previously in the hole, it is *flooded* with water. Of course, it soaks in, but it is increasing abundantly the water to be driven off by the fire. When the fire is taken away from the mould previous to closing, and as there are no exits for the steam in the sand, the vapour gradually finds its way to the face of the mould. The tackle necessary for the top part to sit upon over the fire during drying is not always found at hand, and often entails some manual labour.

Economies from Proper Venting.

When ramming up a mould in boxes which are to be stove-dried, everything possible should be done to encourage satisfactory drying. If a few

* A Paper presented to the Newcastle Branch of the Institution of British Foundrymen.

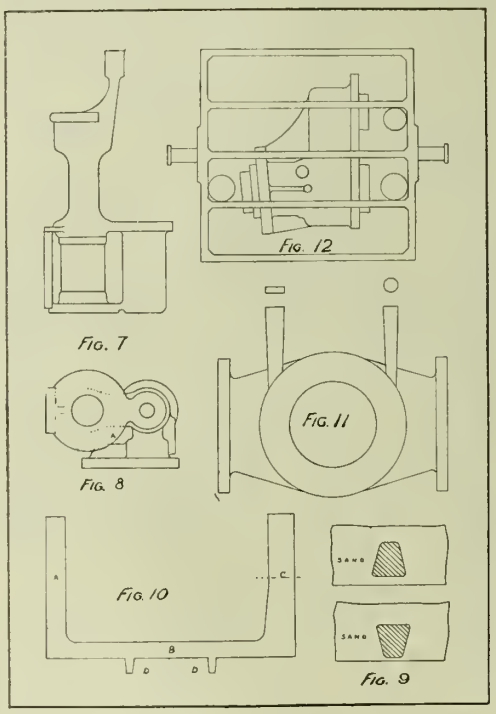
fine ashes are inserted, making a vent passage from an awkward part during ramming up, and several vent-wire holes, about $\frac{3}{8}$ in. dia., reaching well to the pattern after having rammed it, their effect on the mould and casting is very marked. These factors are continually working in aid of the mould and casting from the time of its entry into the stove until it is full of iron and the iron has set. They provide a sharp outlet for the steam from the sand during stoving; they give an easy exit for the steam which is gathering while it is standing after having left the stove; and, lastly, they facilitate the departure of steam and gases formed during the process of casting.

When a mould is finished the boxes can be removed to the stove or elsewhere and the floor space used for something else, but if the mould is in the ground the space is occupied until the mould is cast.

If the bars in a bottom-box are reliable, it should sit on bricks and not on a sand bed. The latter chokes up the pricker holes, besides allowing the warm mould to draw dampness away from the wet sand.

Economies from Limiting Wetting Sand.

The mixing of old sand is often done in a haphazard manner. Many assume, as it has to be dried, it is not necessary to be careful with the water, but in reality the sand only needs to be sufficiently damp so that it will unite readily when



rammed, and by having no excess the moulder is helping the drying of the mould.

Hard and Sound Ramming.

In the operation of ramming a mould the idea is prevalent that dry sand requires to be rammed very hard, whereas *sound* ramming is all that is required, although where straight depths are encountered they have to be made very sound, as any soft places would result in swellings on the castings, caused by the pressure of the iron on the mould. Where hard-ramming has been indulged in, the pattern does not "give" readily to the process of rapping; consequently, when withdrawing the pattern, joint edges suffer damage as well as the mould. Of course, the pattern is blamed for having no taper, but frequently it is the moulder himself who is at fault. The difference between the pressure of ramming *hard* and the pressure of ramming *sound* can only be determined at present by practical experience. In a hard-rammed mould the grains of sand are packed so closely together and are so compact that the gases and steam generated by the hot metal have no easy way of escape through the sand, and therefore return and cause small holes so often to be found in the casting.

Pinholes.

The moulder should consider what takes place while the mould is full of iron. The metal on the mould face solidifies first, and that against the core setting next. Therefore any air or gas-bubbles in the iron will rest in that part of the iron which is molten longest, and that part is nearer the core than the mould face. This, the author believes to be the reason why these small pinholes are mostly found under the skin of the inside of the casting. This fault is more common with castings that have been moulded in the floor.

After the hole has been dug in the floor and new sand put in, the pattern is placed, knocked down to the required height, and levelled. It takes a great deal of force to get the desired effect, and consequently the lowest part of the pattern is making the sand at that part very compact, and, when the pattern is withdrawn, it is found to be exceedingly hard. No notice is taken of this, but probably the sand is ruined so far as any porosity or venting qualities are concerned.

Small holes are often found in castings where the bore requires to be machined, such as castings for balance cylinder-bodies, piston valve-liners, boiler stop-valves and main engine stop-valves (Figs. 2, 3, 4 and 5). Several of this class of castings have been made both in the floor and in boxes, but the author has not encountered a casting with this fault when the mould has been dried in the stove. Of course, moulds of this kind should not be cast with iron at a low temperature, but if dull iron happens to be available the stoved-mould has the greater chance of giving a sound casting if rammed up as indicated.

Engine Stop-Valve Castings.

In moulding an engine stop-valve (Fig. 5), two large brackets are encountered, and any gathering of steam on these will result in their scabbing. Suppose that the bottom half is being rammed up on a turnover board. After the outside has been rammed a few inches sand and irons are inserted in these brackets. Having received about 4 in. of ramming, they should be treated similarly to making a core. A hole is made in the centre to about 2 in. of the pattern, from which small vent-wire holes are made to the fillets of the brackets. A handful of fine ashes is inserted, and a gate stick or narrow tube is made to protrude above the box. The box is then rammed up, and this stick or tube withdrawn.

The regular routine is then performed and the top box placed on. Although the rule in stoved work should be to facilitate drying, numerous workmen are noticed putting wet loam on the joint for the top part. A loam joint is satisfactory where a mould is being made in the floor and has to withstand the heat from the fire, but ordinary dry sand is all that is necessary when the mould is going into the stove. The large brackets have again to be dealt with, and here, as in all cases where brackets, pockets and awkward places are encountered, they should be damped and dusted with parting sand. Whilst the use of loam is not desirable in places like these, however, loam mixed with new dry-sand until "stiffish" placed on these parts and the grate bedded on, makes the pattern withdraw excellently. The remainder of the top is rammed up, but no stick or tube need be used on the brackets, as a few thick vent-wire holes reaching well to the pattern from the top of the box answers the purpose.

This mixing of loam with dry sand ensures a good draw with the pattern in moulding a circulating pump head-valve, owing to the numerous thin facing-pieces, such a pattern possesses, as shown in Fig. 6.

Reversing Engine Cylinder Bodies.

In moulding a reversing engine cylinder-body (Fig. 7) a difficult part is encountered between the barrel and the chest, marked A in the end view (Fig. 8). It is about 8 in. long, with a depth of 4 in. in the chest, and about 2 in. of sand between the barrel and the chest flange.

Care must be taken in laying the irons to hold this part. They must be placed soundly and free from any tendency to spring, which is only found when the pattern has been withdrawn, and which, when it occurs, needs careful attention. It must also be rammed sound, and the irons must not be

hit with the rammer. If this occurs it may loosen a part of the mould face, which may not be seen when finishing, the probability being that it will lift off when the molten metal reaches it.

The coring-up of such moulds requires care in handling the femmer cores, but the advent of the oil-sand core relieves the moulder of a great deal of the skill and precaution he had to use, not only in handling the cores, but in bringing off the vents and keeping them clear.

This mould can either be cast in a horizontal or vertical position, and sound castings can be made both ways. The vertical position entails clamping or bolting the boxes together and turning on end. In the other position, the piece of mould between the barrel and chest causes trouble if care is not taken. The iron fills the chest first, and causes steam and gases to rush through this piece, and if not brought away, scabs will be frequent on this part of the mould. To prevent the trouble, a narrow vent is made through it and brought away through holes in the sides of the box. There is very little room to make it, and care must be taken, or the iron will break into the vent itself.

Whenever the use of grates is undertaken, they should be made as light as possible, but strong, and placed so as not to interfere with the contraction of the casting. It may be observed that quite often a moulder walks a considerable distance in search of a pair of wire twisters when a simple twist of the wire provides one. Fig. 9 shows two views of a section of a grate in the sand.

A grate has a broad side and a narrow round side, and many use the broad side downmost, their reason being that it has a better hold of the sand, in that the broadest part is nearest the joint. With the narrow side down, it is an inch from the joint, but then the sand round the grate is all bound together, but in the other case there is nothing supporting the sand under the broad side except the claywash on the grate. That this is so a moulder finds out when, after turning over the top part, after finishing, he ascertains if all is well, and finds the joint has given way. The jerking of turning over, although sometimes only slight, may be sufficient to cause this lower piece to fall away and perhaps bring an awkward part along with it. This fault is more applicable to green-sand moulding, although it sometimes occurs in dry sand when the mould is roughly handled when charging the drying stove.

Dropped joints are also caused by grates being put on when they have not been hanging level on the wires, but whatever way a moulder uses his grates on the joint of a mould, under no circumstances should a grate be bedded flat-side down on what will become the face of the mould, as, for instance, on brackets of flanges. If this be done in either green- or dry-sand, a scab will very often be found on the casting at that part. The reason is partly explained in the case of the joint grate, but here there is the sand under the flat-side completely absorbing all the claywash on that piece of the grate. The layer of sand, being very thin and overburdened with clay, "gives" from the grate during drying. This is not noticeable during closing a mould, but when the molten iron reaches it, it peels off the grate.

If any dampness be on such places, the steam caused by the molten metal strikes back from the grate and forces the sand away. This happens more especially in green-sand, owing to the dampness of the sand, but the use of the oil-pot sometimes acts as a safeguard. When lifters are used, a good moulder never uses any made of flat iron, round iron always having his preference.

A small-work moulder has to rig together all kinds of boxes and odd sizes, and sometimes a set of boxes, complete with pins for guiding, is at hand to suit a pattern; but very often such kinds of boxes are found wanting, besides being unsuitable. When this is so, guides have to be made accordingly. Various devices are used for this, such as cramping small angle-bars to lugs on the boxes, scratching marks on the boxes, and making loam guides. The use of angle bars is handy when the top part is overlapping the bottom part, and, where lugs are available, on the bottom for cramping the angle bars.

Where box parts are exactly the same size, and there is no overlapping, marks can be scratched on the box sides with the trowel and straight edge. These can be used several times, as they remain on the boxes a long time; but whether boxes have a good or bad fit, the general view is that only one kind of guide can be used, and the loam guide is used extensively. Although at times it is the only one that can be used, it suffers damage very easily, and often, when closing the mould, very little remains as a guide at the final operation.

Loam greased on the box side, where claywater has been applied, should be sleeked with the trowel until it is less than a ½ in. thick, cut at the joint, and again slightly sleeked over. Three or four marks are usually injudiciously made with the edge of the trowel, but if three marks are made with the trowel carefully and widened out to a V-shape, they will be found to stand longer than the former, whilst being more visible, besides looking more workmanlike.

In finishing a mould cleanliness and tidiness are important. All loose pieces of mould should be pulled away, claywash applied, and made up sound, sprigs or brads being added if necessary. Loose pieces of joint should be saved, clay-watered and replaced in position. All joint edges should be made good first, core prints attended to, then the mould proper. Fillets, especially on brackets and flanges, ought to be finished with the fillet tool and not sleeked flat with trowel, as is generally done.

Flat and horizontal surfaces are more liable to scabs, while on round parts they are seldom seen. A good-sized fillet is very desirable, as at these places the thickness between the core and the mould is generally fairly thin.

Water is sometimes used to excess during finishing. In some cases the mould is washed over with a brush before black-washing. The excessive use of water causes the numerous cracks which are found in the mould on its return from the drying stove. They look unsightly, although very seldom causing any trouble, but the stability of the mould sometimes has one in a quandary until the casting is seen.

The placing and cutting of runners is an important matter, and they are very often made with the least care and thought. In castings where freedom from dirt is essential, a good type of runner is shown in Fig. 10. The iron drops down A and runs along B, which is cut in the top part. Any dirt or scum passing down A tends to rise to the top side of B and pass along into C. C should be wider than A, in order that any scum gathering shall not jam itself at the bottom and so prevent the gathering of more, which, if prevented, would remain in B and perhaps enter the mould. D are runners into the mould, and if more than one is cut, B must be increased in volume accordingly. On no account ought the mould to take the iron quicker than will allow B to be kept full. The runners D should be cut as far away from A and C as is judicious, and so ensure the cleanest of iron entering the mould. C need not be made the full height of the box. If made half way, it will save the making up of a riser. It is customary to cut a runner into the mould so that it will reach the lowest part first, but it is not always good policy to do so. For instance, the boiler stop valve (Fig. 4), although possessing a large, thick flange, it is not advisable to use it for the iron to enter. This part of the casting is the most important, being subjected to a continual steam pressure, as it is bolted to the boiler, and any dirt lodging here would be detrimental to the strength of the casting. It is advisable to avoid cutting a runner into a machined part of a casting, as scum generally remains in the boil of the metal, which in such cases would show itself during machining. Sometimes it happens that a mould is best run on top of a flange or on top of the mould itself, owing to the box available not allowing for adequate runner-room. In such cases a flat gate-pin is resorted to, but usually when the gate is broken off the casting several small holes are to be seen. With such cases it is advisable to use the usual round pin if it is possible, as seen in Fig. 12. It is satisfactory, and ensures the freedom from these holes which sometimes enter deeply into the casting. The cause of this may be through gas or air bubbles remaining in the boil of the iron, or the placing of the iron ball in a round gate, keeping back what would

have otherwise passed down the flat gate. If any bubbling of the iron in the mould takes place, a round gate can be worked effectively with a feeding rod, while the chances are negligible in the flat. Risers are generally brought off from the highest part of the casting. They ought to be of good diameter, and not confined the full length to the diameter on the casting.

It is sometimes imagined that where a mould has received too much glaze during finishing this glaze affects the adhesiveness of the blacking. Of course, blacking must not be simply applied to the mould and allowed to soak in. It must be brushed backwards and forwards two or three times in order to knit itself with the pile. If it is not brushed in, it is easily brushed or blown off during closing the mould. If a mould be blacked evenly, and with thin blacking, there is no further need for the use of tools other than squaring up flanges and deep brackets.

When places are met with which are not easily accessible for blackening during the ramming up of the mould, coal-dust should be added to the sand for this part, and the skin of the casting will be found to be clean without blacking. As a further precaution, water-blacking is all that is necessary.

When castings have to withstand high-pressure, the double chaplet should be avoided as much as possible. The ordinary stalk chaplet stayed from the weight is as handy and serviceable as any for small work. Where the usual chaplet-nails are used, much trouble can be avoided, when closing the mould, if a nail is inserted in the various places, to about the required thickness, and withdrawn when the mould is green.

For castings which have not much thickness the chaplet-nail can be dispensed with for supporting cores, and joiners' nails, of soft material, used. The nail of tough steel is not desirable; the molten iron having little effect on the hard nail, and thus promoting the leakages which appear at these places.

The making up and working of vents from cores cause a little trouble at times. They are usually made up nearly flush with the edge of the box with a little taper. Sometimes they are made up too far, and sometimes they are displaced by a slight swing of the top box. If, during the ramming up of the top part, tubes are inserted behind each print and removed when rammed up, leaving holes sufficiently large for the hand to enter, vents will be able to be made up very easily. If it is not possible for a hole about 4 in. dia. to be made, a narrow hole, the width of the print, could be cut out when finishing the mould. When the top box has been lowered for the last time, a full view of the vents can be seen, and there is no necessity for trusting to chance. Narrow tubes can be put in these holes to connect the vent and sand rammed in at will. There is no fear of the iron reaching the vent from over the prints in this manner. It is far better to allow a vent to come away vertically or horizontally than to make it force itself downwards. In conclusion, the author wishes to thank his employers, the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, for permission to give this Paper, also their laboratory for assistance in producing slides, etc.

Catalogues Received.

John G. Stein & Company, Limited, Bonnybridge, Scotland.—A new edition of their well-known red bound catalogue which foundrymen will find of technical value when designing new metallurgical plant, as it outlines standard sizes and the incorporation of such, lowers construction and maintenance costs. It is interesting to note that French, German, Italian, Spanish and Russian editions are also available.

Mr. R. A. Miles, a prominent member of the Lancashire Branch of the Institution of British Foundrymen, has been appointed representative of the Stanton Iron Company for the Manchester district. His offices are situated at Grosvenor Chambers, 21, Deansgate, Manchester.

Influence of Temperature and Fatigue on Accident Rates.

In Report No. 19 (General Series No. 7, just issued) of the Medical Research Council of the Industrial Fatigue Research Board, some further light is thrown on the subjective aspect of accident causation, and in particular on the parts played respectively by speed of production, psychical state of the worker, and fatigue.

According to the Summary to Part A of the Report dealing with "The Influence of Temperature and Other Conditions on the Frequency of Industrial Accidents," by Ethel E. Osborne and Dr. H. M. Vernon, the number of accidents (cuts) experienced by the workers at three munition factories was found to be greatly influenced by temperature. This was registered continuously by thermographs for nine to twelve months at a projectile factory and a 6-in. shell factory, and it was found that the accidents at the shell factory agreed with those previously observed at a fuse factory in reaching a minimum of 67 deg. Fah. At the projectile factory the minimum was at 72 deg., but the combined results gave 67 deg. as the minimum. With fall of temperature the accidents increased gradually, and to a similar extent in the case of men and women, till at 52 deg. they were 35 per cent. more numerous. At temperatures above 72 deg. they increased very rapidly in men, but only to a small extent in women.

The hourly incidence of accidents experienced by the day shift at the projectile factory showed a qualitative resemblance to the output variations. They were low at first, rose to a maximum in the middle of the shift, and then fell away. The night-shift accidents, on the other hand, showed no resemblance whatever to output, except during the last two hours. They were at a maximum during the first hour, then fell off sharply, and finally sank to less than half their original number. Probably this incidence was largely psychical in origin.

The influence of fatigue in causing accidents was shown at the 6-in. shell factory. When the women worked the same 61 hour week as the men, their accidents were 91 per cent. as numerous, but when their hours were reduced to 39½ a week (those of the men being unchanged), their accidents fell to 78 per cent. of those experienced by the men.

In the Summary and Conclusion of Part B, "On the Relation of Fatigue and Accuracy to Speed and Duration of Work," by Mr. B. Muscio, data are given showing that (1) an increase in rate of movement (for certain rates used) causes an increase in the inaccuracy of movement, and that the faster the rate in operation at any time, the greater in general is the increase in inaccuracy produced by any unit increase in rate; (2) continuous work for several hours (in one case for 3½ hours) with tests of motor precision fails to show any gradual increase in inaccuracy but the very reverse, the resulting inaccuracy curve being almost the exact opposite of the typical industrial accident curve for the morning hours; (3) a curve for inaccuracy of movement, broadly similar to the typical industrial accident curve for the morning hours, can be experimentally obtained by gradually increasing the rate of movement in a morning period of continuous work with motor precision tests.

In view of what is known concerning hourly variations in speed of production, the conclusion suggested by these results is that the principal factor in the hourly variations in the number of industrial accidents is not "fatigue," but rate of work.

Associated British Machine Tool Makers, Limited, have removed their Sheffield branch from Bank Buildings, 63, Blonk Street, to 4, Summerfield, Broomhill.

The imports of foreign iron ore at the Senhouse dock, Maryport, during last month amounted to 3,000 tons, compared with 3,500 tons for October. There were no imports of ore at the corresponding period of last year. The imports last week amounted to 3,500 tons.

Gating, Feeding and Casting.

By E. Longden, A.M.I.Brit.F.

(*Continued from p.* 472.)

Castings have been saved, when likely to be lost due to an insufficiency of hot feeding metal, by throwing sulphur into the congealing metal. Iron sulphide lowers the melting temperature. This is, however, a dubious procedure, as one would have little faith in the metal about and under the riser. In the case of a casting requiring metal of any description, it might succeed.

The author does not agree that castings cannot be fed with the rod beyond locally; for example, a flywheel of about 10 tons fed by one riser on the rim, the boss being used as the section through which to pour the casting. The metal is very hot here, but is not fed, except by the movement in the metal created by the use of the rod in the riser.

In the case of large moulds, the setting of the metal can be felt by the rod meeting solidifying metal getting nearer and nearer. The metal cools from bottom, then sides, and lastly the top-middle portions.

Under and Over Feeding.

One can underfeed and overfeed. Many cases have come to light of castings being quite spoilt by overfeeding. Overfeeding destroys the structure of the metal, which might exhibit itself in very open grain, with gases entrained or in a distinct cavity. It can be tested by feeding rapidly for a prolonged time, and the metal can be reduced to fine particles made up of small groups of oxidised and injured crystals. The damage to the crystals is clearly noticed in the banded structure of almost any gate which has been fed over a lengthy period. Underfeeding is too evident to remark upon to any length. It is much better to remove what was intended to be a feeding riser if no real attempt is made to feed properly. In some cases cores help to feed a job.

Open or Closed Risers.

When employing drop-runners, the force or impact of the metal when it strikes the bottom side of the mould is almost like a hammer blow. With a closed riser the cutting effect is not quite so violent, because the air in the mould is somewhat compressed. This compressed air may save the scabbing and drawing in of the top part by preventing the surface gases from penetrating the mould cavity. Some amount of protection is also given to the top part by the lack of heat conductivity of gases. Compressed air may prevent the complete filling of the mould. In thin moulds made of loam and dry-sand, it is advisable to leave risers open. The metal will rise more freely. This is also true when pouring with stiff and sluggish iron. Quite a large number of wasters are caused through collected and trapped gases. If the mould has been burnt, it is advisable to keep the riser closed.

Flywheel and other heavy casting moulds should have closed risers. In the case of a flywheel, even the air at the joint ought to be excluded. Loam tops of large area will draw-in when using an open riser.

If a large mould be run short or the runners become clogged, a drawn-in top is likely to result if the risers are open. It is analogous to the drawing-in of a mould when placed to dry over a too-hot fire, although this may be due to a faultily-constructed mould.

With open risers, a strong current of gas will be noticed. Large volumes of gases are formed in the moulds generated from the sand materials and metal. These gases expand greatly, due to heat radiation, so that if the riser be kept open, the tendency will be for the gases to strike into the mould, to be expelled through the riser instead of by the properly-constructed vent channels. Risers which in Lancashire are termed French risers are put on simply to allow a free filling of a narrow part of a mould which would otherwise be run short due to gas pressure.

Head-Metal.

Head metal is an addition to the height of the mould to receive scum and to provide metal for feeding. Extra height in the head will help to feed, even through thin sections, and also to expel gases.

A lack of head-pressure would be especially noticeable if the metal be sluggish. When the metal freezes too quickly, the ferro-static pressure is relieved. This can be seen very plainly if one examines the bottom portion of the runner-gate adjoining the casting. There one will see at the juncture blow holes. The iron below has simply relieved itself of surplus gases, which are trapped in the hot spot in front of the runner.

The head or height of a column of molten iron makes only a small difference in the specific gravity of metal, but in the author's opinion it makes a great difference in the aid to the vents. With plenty of head-pressure, the vents are more easily persuaded to fulfil their proper function. The author's earliest recollection of a case where the provision of a good head-pressure meant success occurred during the latter part of his apprenticeship at a Manchester firm. At this particular firm they were making motor-car engines. In casting the cylinders they thought themselves lucky if they secured one good casting out of three cast. So soon as the metal appeared in the riser bush, they would blow. They tried to secure better results by constructing a run-off riser, actually reducing head-pressure. Noting this, the author hinted to the foreman that instead of running off, they might secure better results if they increased the depth of runner and riser basins. They were increased, and no further wasters resulted from that special reason.

Runner Basins.

Much carelessness is often noticed in the construction of runner basins. When pouring, little can be done. Months of work may be spoiled due to a little neglect. In making up a green-sand basin for medium and heavy work, it is advisable to ram the runner-box completely with sand, and then cut out to the desired shape. If much metal is to be poured, a piece of core or loam cake should be bedded in the dished-out place where the metal is first poured.

In heavy work the runner basin is often made up in loam or dry-sand, and stoved the night previous to casting. Wherever the basin cannot be constructed conveniently apart from the mould, it is made and dried in position.

Whenever the runner basin protrudes over the area of the mould, much care is needed in conducting the gases away from underneath the bush. The reason for this is obvious. Whilst pouring, gases are generated, and rise through the mould directly underneath the runner basin; add to this the gases from the material of which the runner basin is constructed, and there is a very formidable danger. Whether the basin is dried or not, means of conducting away the gases must be employed. Wisps of straw, wire holes and cinders are used for this purpose. In spite of such precautions when making large moulds, it is not unusual to find the bottom of the runner basin break and blow up immediately the mould has filled and the pressure released by the lower head of a run-off riser. Although the casting may then be safe, it is highly dangerous to the men engaged upon the cast.

Quite often a moulder is astonished at his good fortune, the morning following a previous night's blow-up, at securing a good casting. The blowing had not effected the casting. It was simply a case of the gases rising from the mould through the runner basin and metal. When pouring heavy castings it is advisable, wherever possible, to construct the runner basin outside the mould.

In much work precautions are necessary, when

pouring, to exclude the dirt and scum which collects and accompanies the first metal poured. Stoppers are placed over the down-runners and lifted immediately the basin is full, thus enabling the metal to gather its scum on its surface.

It is astonishing how little attention is paid to the correct forming of the mouth of the down-runner. Quite experienced moulders exist who will draw a gate-peg, leaving a proud, sharp edge to be broken by a flat stopper or scoured and washed away by the metal. The detached sand may enter the mould. In special work it is advisable to form the mouth of the down-runner in a core, so that a ball stopper can be employed. A piece of tin is sometimes placed over the gate entrance, which gives the caster just enough time to flush the basin full before it is melted.

Gating and Feeding Other Metals.

Correct gating and feeding of malleable iron and steel is much more important than in producing grey iron. Sometimes, reluctantly, a useful design of casting is rejected when the gating or feeding is at fault. The considerations are:—How can the castings be poured cleanly without a mis-run? Must feeding be done by way of runner or riser gates? In either case the proportion, location and area must be so that the weight of metal feeds down into casting. Funnel-like cavities in feeding heads show that good work has been done. When pouring light malleable iron, the metal is almost thrown into the mould by a twist of the wrist controlling the pouring. Many of the precautions taken to produce sound malleable and steel castings are used in the production of non-ferrous castings.

In the case of aluminium, good results are obtained by splitting and increasing the number of in-gates in a similar way to running iron. In-gates are sometimes placed entirely around the whole casting. Down-gates are made larger than in the case of brass and gun-metal.

Aluminium requires to be poured quickly. To depend on force of gravity would not be sufficient. As is the case when pouring light malleable iron, the metal is pitched into a large down-runner.

(To be continued.)

German Iron and Steel Industry.

The Iron and Steel Ware Industrial Union announces that the Export Tax Committee of the Economic Parliament has suggested to the Ministry for Economic Affairs that the export tax on all products coming within the competency of the Foreign Trade Bureau for iron and steel ware should be reduced to 2 per cent.

The German-Russian Trading Company, the proposed constitution of which was reported in this column a few weeks ago, is now being formed in Berlin under German laws, and with a share capital of 350,000,000 marks. One-half of this sum is being provided in cash by the Soviet Trading Delegation in Berlin and the other half by the group composed of the firm of Otto Wolff, the Phœnix Steel Company, Rhenish Steel Works Company, and the Zypen and Wissen Steel Works Company.

The Westerwald (Hachenburg) Montan Company has been formed at Wiesbaden by the Banque Commerciale de la Sarre of Saarbrucken, with a share capital of 121,000,000 marks. The company has taken over the iron ore mines of four corporations—Friedrichshoffnung, Alter Garten, Konigsberg, and Rheinberg—whose properties are in the vicinity of iron ore mines belonging to the F. Krupp Company.

It is reported that the negotiations for the transfer to the Russian Asiatic Corporation of the Friedenshütte of the Upper Silesian Railway Requirements Company, which is now situated in Polish territory, have failed to mature. The German proposals, it is said, afforded no basis for consideration on the part of the English interests.

Consolidated Pneumatic Tool Company, Limited, of Egyptian House, 170, Piccadilly, London, W.1, have removed their pneumatic and electric repair shops and showrooms from Petty France Street, Westminster, to Bramber Road, West Kensington, W.14. Mr. R. Jones, manager of the company's office at Amarchand Buildings, Ballard Road, Fort, Bombay, has retired owing to ill-health, and Mr. C. C. Walcott has been appointed his successor.

Oxygen and Metallurgical Processes.

Mr. Cosmo Johns, of Sheffield, made a contribution to the joint discussion of the Faraday Society and the British Cold Storage and Ice Association on the generation and utilisation of cold. He said that most of the useful metals in present-day practice are extracted from their ores and refined for industrial use by processes which involve the use of atmospheric air for the combustion of carbonaceous matter, silicon, phosphorus or sulphur, to provide the heat required. These processes have become standardised to a large extent, and are based on the assumption of the invariableness of the oxygen content of the atmosphere. Obviously the oxygen enrichment of the air used would alter the conditions under which those metallurgical processes which depend on oxidation of some fuel for the heat required are carried out, and though it is difficult to predict what would actually be the effect of such altered conditions, yet enough is known to enable us to say that revolutionary changes in metallurgical practice would result. The processes now employed, and the types of plant used, are the result of gradual evolution of industrial practice. Our knowledge of the reactions that occur are imperfect and almost entirely restricted to our knowledge of what occurs when ordinary air is used. But though it may be difficult to predict the actual changes in practice that would result, it is comparatively easy to review the possibilities. It is important to note, however, that what is contemplated is not the use of pure oxygen, but the availability of a mixture with 30 to 40 per cent. of oxygen, or even less.

The modern blast-furnace plant would obviously undergo a startling change in its design and arrangement when it had no longer to handle the present huge volumes of dust-laden heated combustible gases to effect difficult heat exchanges with the incoming air to secure fuel economy. The hot-blast stoves would probably disappear, or be much reduced in size. The furnace itself would be reduced in height, and the whole plant, when the changes had been completed, would bear but little resemblance to the equipment found necessary to-day for the production of pig-iron. The Bessemer converter, whether acid or basic, has been evolved on the assumption of an invariable oxygen content of the air blown in. Given the possibility of varying and controlling the oxygen ratio in the air employed, we should find the character of the process completely changed.

In the acid process the order in which carbon and silicon are removed depends on the temperature. In the basic process it is almost certain that by controlling the temperature it would be possible to oxidise the phosphorus before all the carbon had been removed, and thus the injurious after-blow would be avoided. This temperature control could be effected if the oxygen content of the air blown in could be varied. The regenerative open-hearth furnace is costly, complicated, and inefficient from the thermal standpoint. If oxygen-enriched air could be employed for the production of the fuel gas, and for its subsequent combustion in the hearth of the furnace, it would be possible to effect a startling and beneficial alteration in the plant. The uni-flow furnace would become a possibility, and there would be a very desirable simplification in the design of the furnace. A neutral or oxidising flame would be at the command of the operator, while the melting and refining operations would be accelerated. The waste gas of the furnace would be much richer in CO_2, and with added oxygen rich air would be ideal for blowing into the gas producer, thus enabling a fuel gas rich in CO to be supplied to the furnace.

Owing to the slight difference in density of oxygen and nitrogen it would appear that centrifugal methods for their separation are not very hopeful. Can any refrigerating system be devised which will give oxygen enriched at a commercial price? Any such refrigerating system should be able to use as the source of the energy it requires the sensible or potential heat of the products of the metallurgical process where it is employed, if carbon be the fuel used in the process. If a suitable cycle can be discovered for effecting the partial separation of the two mixed gases, for complete separation is not required, then a vast field is available for the use of oxygen-enriched air.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

Discussion on Mr. Young's Paper on the Manufacture of Coke for Industrial Purposes.*

At the annual meeting of the Branch held in May, Mr. A. D. Young, of Burnley, read the first part of a paper on the manufacture of coke for industrial purposes. He now gave the second part of it, which dealt with the requirements of the iron trades. Opening the discussion, the chairman said coke was a very important factor in a foundry, and they welcomed anyone who could add to their knowledge, especially if he could indicate some way of inducing the makers to improve the quality. Lately there had been a distinct improvement in certain brands; on the other hand some had fallen off. They wanted a coke with considerably less sulphur and ash.

Foundrymen should Issue Coke Specification.

Mr. Young said it was easier to ask for low sulphur coke than to get it. As he viewed the situation foundrymen had to make up their minds what they wanted, what they would take and what they would not take. If they went on taking what was offered suppliers would continue to send it to them. If a definite standard specification was established it would be a basis when buying coke, and buyers could complain and refuse material when below the standard. The paper indicated what had been accomplished elsewhere to attain a standard specification. The results, so far, had not been ideal, but they certainly helped. Research associations were investigating various subjects in connection with combustion, and possibly they would turn their attention to coke, and supplement the work already done on this material.

Mr. Hogg, of Burnley, asked whether Mr. Young could state the reason for both inferior and some of the good brand cokes having a high sulphur content, 2 per cent. or more; did he know of any method of desulphurising the coke after it got into the foundry? When trade was good, it was difficult to get good coke, and the latter question became both pressing and valuable if it could be accomplished cheaply.

Experiments on Sulphur Removal.

Mr. Young said the subject of commercially desulphurising coke had been before the interested engineers' associations, but nothing had been proposed which could be said to be satisfactory. There had been a suggestion that coke should be quenched in an excess of water or steam, so that on combination, the sulphur would unite with the hydrogen liberated from the decomposed steam and disappear into the air in the form of sulphuretted hydrogen. Certainly a small amount would be carried away by this method, but the probabilities were that it would not be above 1 or 2 per cent. of the total sulphur present. The matter should be looked at from the point of view of what was the sulphur doing there and how did it get there? It occurred in three forms, iron sulphide or pyrites, organic sulphur and the calcium sulphate. When the coal was carbonised the sulphur in the pyrites, if not in double combination, would be volatilised and pass away in the gases, but supposing this removed all the sulphur in the pyrites there was still the calcium sulphate and organic sulphur left in the ash. That was fixed and could not be removed. It seemed that the only way in which a coke free from sulphur could be obtained was by judiciously picking and well washing the coal before carbonisation. Until some cheap and efficient process was evolved it remains necessary to choose coals which were fairly low in sulphur and well wash them so as to have as little dirt as possible before carbonising.

In the States Mr. Powell has investigated the reactions of coal-sulphur during the coking process and suggested the use of hydrogen as a desulphurising agent, the sulphur being evolved as sulphuretted hydrogen. The results on an experimental scale were exceedingly good, but the process has not been tried in practice.

Quenching the coke by water with the addition of hydrochloric acid has been proposed for the removal of sulphur, but the process is prohibitive due to cost of working.

The Chairman (Mr. R. A. Miles) suggested that it is very difficult to change one's source of supply.

Mr. Young agreed, and thought the matter ought to be examined, also from the point of view of the coke-oven manager. As a rule an order for coke did not specify its use, which obviously varied. People were beginning to realise what could be done as to the manufacture of different grades of coke, and practically all the coke-oven builders had a staff of research chemists. If anything was possible they were in a position to develop it. But until the foundryman could say definitely what was needed and insist upon it, he must take what he could get.

Lime Covering During Coking.

Mr. Hogg asked whether a layer of lime placed on the top of the coal before carbonisation, say in a beehive oven, would have any effect upon the sulphur.

Mr. Young replied that he did not think for a minute that it would. The lime itself would not absorb sulphur from the coal being carbonised; but, assuming that it was in a position to absorb sulphur, it could only absorb sulphur from the gas which passed through it; it could not absorb sulphur from the coal below. Some seven or eight years ago, in an attempt to reduce the amount of sulphur in town's gas, a process was devised whereby a small amount of lime could be mixed with the coal. It was known as the "liming" process. As the coal passed down into an elevator, boot, or into any other convenient apparatus, just before it entered the retorts, a jet of steam was blown on to it, and deposited a small charge of powdered lime, covering the coal with a thin film of lime, just as if it had been dusted with a flour dredger. This was adopted by Mr. Patterson, the Gas Engineer of Cheltenham, who found improved results by it; from a gas-making aspect, the sulphur in the gas was certainly reduced a little. But that method was not applied by any by-product coking firm producing coke for industrial purposes, as the lime would still be in the ash of the coke. It was applied in one or two gasworks, but not generally. Other methods of reducing the sulphur compounds in the gas were handier. The Fuel Research Board and Prof. Cobb, of Leeds, were researching on the subject of cell space. One must have a coke that had a certain porosity, so that the gases would get it and pass through it for combustion to be completed rapidly. At the same time, the coke must have sufficient hardness and strength for the purpose for which it was required. Not much had been done in the matter up to now, but he thought the question of cell space would become very important in the future in relation to the combustibility of coke. Porosity was formerly thought the main factor, but now the question of cell area was considered important. If the user could get coke of the same strength, but with a larger cell area, so much the better. Coke was no use unless it was combustible, and the larger the cell area, the more combustible it was.

Foundry Requirements.

Mr. Young, replying to the Chairman's query as to whether any simple practical means of ascertaining the cell area existed, stated that it was a very complicated matter, as one required to know much about the size and thickness of the cell wall material and distribution of the cell area. In the course of a year or two, more information would be available. But what really concerned foundrymen at the present moment was the adoption of a standard specification to obtain a standard product. When the specifications quoted in the Paper were examined, the matter would be a little clearer than it now appeared. The foundryman did not want coke that had "black ends" in it, because those indicated that the material had not

* This Paper was printed in November 23rd issue of the Foundry Trade Journal.

been properly carbonised. It should be dense, have a close texture, and should have a metallic ring when dropped or struck, and not a dull thud. He should also beware of coke containing red rust spots. "Rusty" coke shows the presence of iron oxide, and invariably contains a high percentage of sulphur. Coke containing a large amount of shale will not be conducive to economical working. The foundryman's preference for a good silver-grey colour can be understood, as his experience tells him it has been properly coked and quenched.

Size of Coke.

Mr. Sutcliffe asked whether, in cupola practice, it was better to have the coke in large lumps or in small.

Mr. Young said very small coke was not of much use; when very fine it clogged the cupola. It depended upon what suited the particular size of plant. Practically the same thing occurred in gas-producer practice; one plant would work with a fairly large coke, and another would not. A few trials with coke graded to different sizes would show which was the best to work with. Probably the medium size was the best. With very large lumps the gases got away too easily, and carried away surplus heat, which would be taken up if the coke were smaller and the passages between more irregular.

Mr. Sutcliffe said, in a beehive oven, one always found a central split or fracture when the door was opened. What was the cause of that?

Mr. Young said the same thing occurred in by-product ovens. In beehive ovens carbonisation started at the bottom, and it also went from the top downwards. At the bottom the coal was carbonised fairly quickly, but in the middle there was a portion which was more or less plastic, due to the fusibility of the coal because of the pitch and tar which had settled in it from the gases, it being the last portion to become coked. The strength of the coke was somewhat proportional to the length of time it was subjected to the coking temperature, and the result was that, when raked out, it usually divided in a fracture down the middle.

Ageing of Coke.

Mr. S. Smith asked whether the keeping in store, say, for 12 months, had a detrimental effect?

Mr. Young said the constitution of the coal must be considered. According to Professor Lewis's views—they were perhaps not exactly correct, according to present-day knowledge, but they gave the best explanation—there were four things in coal:—(1) The carbon residue; (2) what he called the humus bodies; (3) the resins; and (4) the hydro-carbons. In the course of time the humus bodies would increase more or less at the expense of the resins, which, through oxidation, deteriorated in quality. When the resins so deteriorated, the coke formed was of inferior quality. He thought it was rather a controversial question whether coal was better kept under cover or in the open. Generally, coal would not oxidise so much if kept in a covered store, with a roof above, because there was not a constant change of atmosphere.

Mr. Smith said his question referred to coke, not coal.

Mr. Young said he was of opinion that coke did not take any harm through being stored in the open, provided it did not get wet. There was often a tendency for coke to break down into breeze to some extent. Supposing there was 5 per cent. of breeze when the coke was first bought, the proportion might be increased to nearly 10 per cent. at the end of six months. But the coke itself would not alter in composition. The proportion of breeze was much increased by repeated handling of the coke, especially if the coke was dropped from any height.

Mr. Sutcliffe: If the proportion of breeze increases from this cause, how is the coke going to stand the burden when it gets in the cupola?

Mr. Young said, apart from the fact of breaking up, the coke itself would be no worse. A good hard coke did not break up to anything like the same extent as a soft coke. He agreed it would not stand as well in the cupola, and the extra small or breeze may disarrange the working of the cupola. It has been proposed in blast-furnace practice that it would pay to screen out the small before using the coke, due to the increased output of the furnaces when using coke of proper size.

Mr. Smith: The coke would then become more friable.

Mr. Young said he had heard it expressed that coke could stand for 20 years without taking any ill-effects, but was not in agreement with this view. His own experience of the storage of coke at gas-works was that it did not deteriorate as regards its burning qualities, but the percentage of breeze increased as the height of the store heap increased. The formation of excessive breeze, in his opinion, was due to overcoking or improper quenching, but metallurgical coke was not so likely to break down in storage as gasworks coke, as it is more dense and less friable.

Vote of Thanks.

Mr. H. Sherburn, in proposing a vote of thanks to Mr. Young, said they were very fortunate in getting the views of a gentleman who was outside the foundry industry, and who looked at these matters from a judicial standpoint. He had not shown them, however, how they could get coke free from sulphur. Sulphur was blamed for many things, and appeared as a good peg to hang troubles upon. At one of the Conferences of the Institution it had been stated that it was not proved that sulphur, up to a certain percentage, was actually an evil; in fact, reasons were given which seemed to show that it was beneficial under certain conditions. The situation was still very obscure and complicated by much prejudice. Probably a greater problem for the foundryman was the question of uniformity. Uniformity in coke was as important to them as uniformity in pig-iron, but they were far from getting it, and in this variation of materials—both in foundry materials as well as furnace materials—lay much of the difficulty which besets the foundryman to-day.

Mr. Grandison seconded the vote of thanks, which was passed unanimously.

NOTES FROM THE BRANCHES.

Newcastle.

From the November meeting a message of congratulation was sent to Mr. Edward Smith, a past Branch-president, on his re-election as Mayor of South Shields.

Mr. H. A. J. Rang was accorded the thanks of the meeting for the time and work he has expended on the Branch booklet.

Patent Specifications Accepted.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, W.C.2. Printed copies of the specifications in the following list are on sale.

Mechanical Transmission and Appliances.

172,931. Holte, H. Centrifugal friction clutches. (December 14, 1920.)

186,054. Vullierme, M. Shaft coupling for damping engine pulses. (September 13, 1921.)

Plant.

188,379. Grote, L. Method of and means for mounting liquid hydrocarbon burners on furnaces or other apparatus. August 5, 1921.

188,422. Burgess, C. L. Fire-bar for boilers and other furnaces. August 26, 1921.

188,445. Clayton, H. F. Oil-burning furnaces. September 12, 1921.

188,515. Metropolitan-Vickers Electrical Company, Limited. Condenser systems in steam-power plants. October 29, 1921.

188,547. Millington, W. E. W. Centrifugal pumps. November 28, 1921.

188,550. Gibbons, Bros., Limited, and Cook, N. G. Machines for discharging and charging furnaces or retorts. November 30, 1921.

174,055. Suczek, R. Turbines. (January 10, 1921.)

188,579. Ferrall, M. Chain-grate furnaces for boilers. January 3, 1922.

188,623. Rigby, T. Preheaters for evaporators, etc. (May 10, 1921.)

An Apprenticeship Course in Foundry Practice.—XXII.

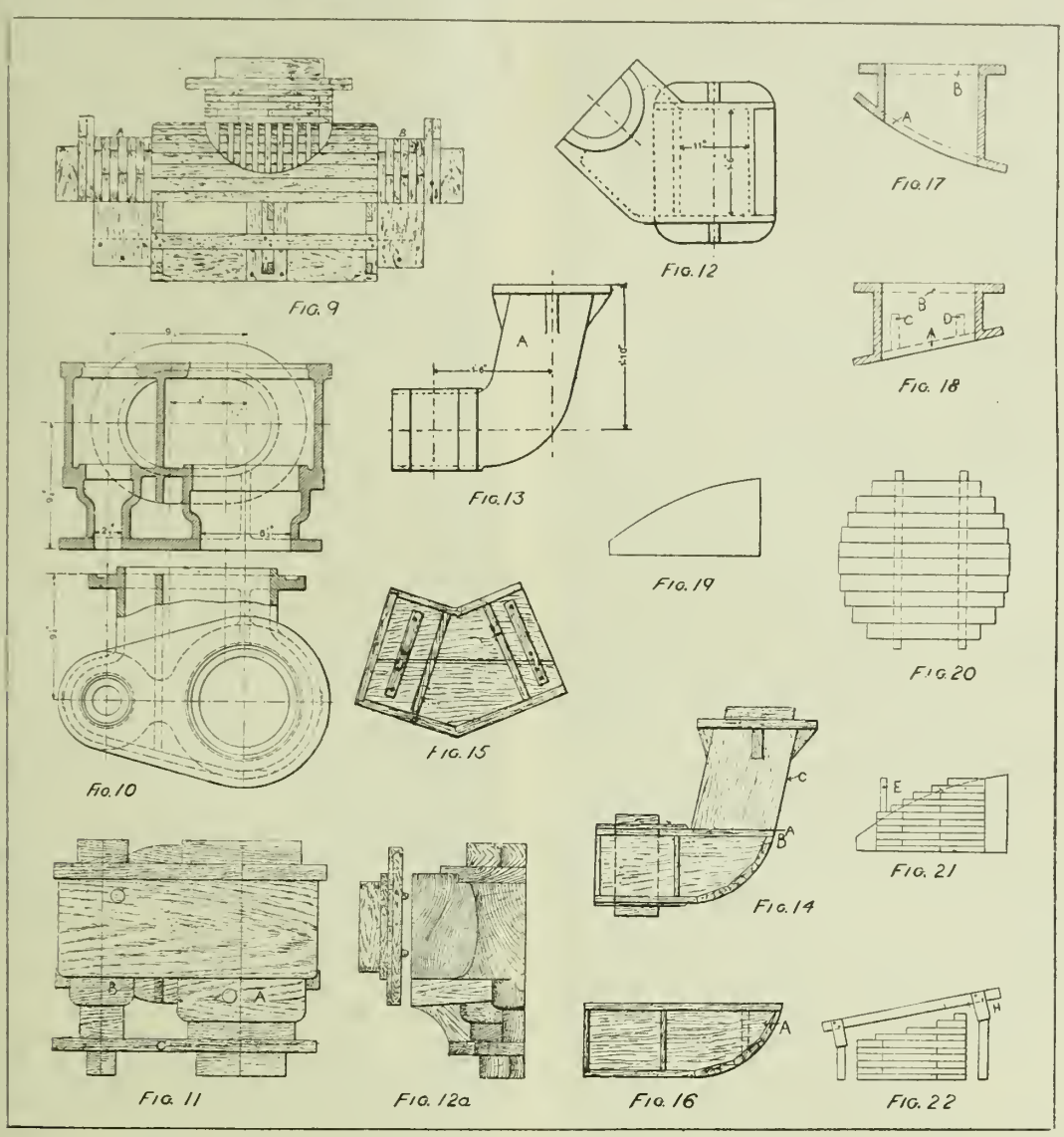
By Ben Shaw and James Edgar.

BUILDING PATTERNS. EXAMPLES OF DIFFERENT TYPES.

PART II.

Plain Cylindrical Patterns.

We shall now leave the separate consideration of detail work, and deal with a few simple patterns which will cover many of the difficulties with which the apprentice is faced. Fig. 9 shows a pattern for a cylindrical casting, the large-body diameter of which is 2 ft., while the flanges are 2 ft. 2 in. dia. and the branches 18 in. dia. The pattern may be built of separate units, that is, the joint frame could be dispensed with, but a permanently better joint is obtained and there is less trouble involved in building when joint plates about 1¼ in. thick are used. The drawing is very nearly self-explanatory. Circular grounds are made and screwed to the frames, as shown, and the staves secured to them. The shape may be completed on the frame, or a more convenient method can be adopted of introducing stays, to maintain the correct position of the grounds, when it can be built as a separate piece and attached to the frame when completed. The same may be said of the segmental ends A and B. It will be observed that the frames do not extend beyond the backs of the flanges, which is good practice for several reasons, one being that an alteration in the diameter of the flanges is more easily effected. Attention may be drawn to the branch, which shows a different fitting from what we have already described. The joint might or might not be carried to the back of the branch flange, depending largely on whether the work would be likely to be altered. In the illustration part of the branch is made by the skeleton method, but, if many castings were required, it would be profitable to fit blocks to form a solid exterior, a jig being used for the purpose. This is a form of construction that covers a variety of patterns. The frames would, in the first place, be finished with a square edge, the main barrel screwed to it from the joint face, after which the end parts A and B, the flanges and prints would be screwed in position. After the branch had been finished, the two half-patterns would be clamped together, and the edges of the joint frames pared and planed to correct shape.



A Combined Valve Chest.

The single-valve chest does not offer many special difficulties, but it will be advisable to consider briefly a combined valve-chest, which is, in one form or another, a very common form of casting. Let us suppose that a pattern has to be made for a casting similar to Fig. 10. If a first-class pattern were required, the flange timber would be made sufficiently thick to allow of the fillet between the flange and body being cut from the solid timber, while the branches A and B (Fig. 11) would be turned with prints attached. More ingenuity is necessary in many cases to make work quickly, and at low cost, than a first-class job which occupies more time, and this pattern could be made very much quicker if only one or two castings were required. It may be agreed

by some that the apprentice should only be shown the best work, but, on the other hand, the highly-skilled craftsman is the man who can adapt himself to circumstances; a cheap pattern may, after all, be a very good pattern. The simplest method of making such a pattern is by means of sectional construction, as shown at Figs. 11 and 12A. Fig. 11 illustrates half of the pattern looking on the joint, and Fig. 12A is an end elevation showing the branch. It will be noticed that several different thicknesses of timber are required to make up the width over the prints. The rounded parts shown on sections A and B and the junction between the flanges of section C are worked by hand. The centres of each piece are carefully squared over, and the thinner sections screwed to the main section. The method of constructing the top branch and flange is apparent from the drawing.

Bracket Patterns.

Bracket patterns constitute a different branch of pattern construction. Some brackets of boxed design, having many openings or "windows" through the walls of metal, can be most easily made by coring the entire inside shape of the bracket, and some small delicate brackets must be built on a block which forms a core print. When a bracket is of very light design and awkwardly shaped, the method of coring should be considered. In any general article it is not possible to cover the whole range of bracket types; nor is it necessary, if the apprentice has profited by previous articles of the series. But we shall describe one type of bracket which must be boxed up, and which frequently perplexes experienced men. We refer to a weight- or wyper-shaft bracket. These are not all of the same design, but they are sufficiently similar to be covered by one design, such as is shown in Figs. 12 and 13. One difficulty results from the square section not being all in the same plane, and this difficulty is increased by the large radius shown in Fig. 12. Sometimes the job is simplified by the part A (Fig. 12) being quite short—in fact, merely a flange resting on the bottom part—and occasionally there is a large radius, the two sides meeting with the sharp corner rounded off. This is one of the few jobs where the patternmaker has not to give special consideration to the moulder, but can concentrate his attention on constructing a really strong pattern. An irregular-shaped pattern like this must be very strongly made, or a knock in the foundry will render it inaccurate.

The body of this pattern must be boxed up in two distinct pieces, that below the line A-A in Fig. 14 forming one piece and that above the other (Figs. 15 and 16) shows the method of boxing up. B is a plate which forms the base on which the work is built. A view looking on the plate when the end and sides have been screwed to it is shown at Fig. 15. It will be observed that the end A is let into the sides, which prevents any possibility of it being knocked in. The sides have to be in two lengths, butted together. With regard to the thickness of timber, it should not be less than 1¼ in. The large radius would be staved as shown at A (Fig. 16). This completes the boxing-up of the bottom part of the pattern, and boxing the top part C (Fig. 14) is comparatively easy. The shape of the sides is obtained from the full-sized drawing, and they should be checked at the ends, so as to form a shoulder for the end pieces.

The weight-shaft bracket pattern described might be moulded with the square flange down, the moulder either making a joint round the large radius and down to the top of the square flange or carrying it along the line A-A (Fig. 14), in which case the square box would have to be screwed, so that the moulder could loosen it in the sand and draw it out after the bearing piece had been withdrawn.

Patterns for Castings to Fit on Irregular Shapes.

Before leaving the subject of pattern building we shall describe a job of a type which presents unique difficulties of construction, although in design it is very simple, and which also demonstrates the great usefulness of hermaphrodites. This is a casting (Figs. 17 and 18) which fits on a ship's side. For cheapness and effectiveness a shell pattern is better than a solid pattern and core-box, because of the awkward flange face. Only approximate particulars are usually given on the drawing for the shell flange A (Figs. 17 and 18), the job being usually set down from templates or moulds supplied by the moulding loft, the object being to have the flange B vertical when in position on the ship. After the job is set down two sets of templates must be made by the patternmaker, the one set to be used when building the body and the other set when building the flange A.

Considering the flange A first, the positions of the templates are set down on the drawing board as C and D (Fig. 18), the other view of them being as in Fig. 19. The flange should be built on top of the templates, which have been fixed to a level board. If it is of large diameter—say over 2 ft. —strips of timber 3 in. broad will be satisfactory; but if it is a quick radius, it will be well to have them narrower. A safe rule is to keep them as broad as possible without it being necessary to plane them concave and convex. This flange, as it will appear on the building board, is shown at Fig. 20. The strips should be carefully jointed and glued, and a screw fixed at each end. If care has been taken, scarcely any finishing of the flange faces will be necessary. Before it is lifted from the building board, centre lines must be lifted as a guide for it being screwed to the body of the pattern.

The templates necessary for the body are similar to those made for the flange, but they must be placed outside the diameter of the body. The use of them when building saves time and timber, obviating the building of the ring of parallel depth. A straightedge shows the height necessary at the various points on the circumference. Fig. 21 makes this clear. When the ring is built—and it ought to be well glued—the centre line should be lifted to the bottom course of segments from the drawing board. Lifting the work now, centre lines can be drawn across the face. This will facilitate replacing the ring in the proper position when the top is ready to be worked off to the shape. Temporary legs ought now to be screwed to the bottom course of segments to the height of the top course, as at E (Fig. 21). If the outside diameter is now drawn on the face, the work can be easily sawn at the band-saw resting on the legs. When the outside has been either planed off or finished off at the sandpapering machine, the inside diameter can be gauged on the top side, the legs being removed. When the inside has been finished off, the ring can be replaced on the building board and planed off, using a straightedge. A quicker method is to make a gauge by means of a straightedge and hermaphrodites. Two thin strips can be secured to the straightedge, which will rest on the templates, and raise the straightedge sufficiently high to clear all the segments. The hermaphrodites are set to the distance H (Fig. 22). As the straightedge is lowered on the templates, the hermaphrodites should be held at right-angles to its edge and a line drawn. If lines are drawn inside and outside, it will be a simple matter to rough off with a gouge, finishing with a chisel. When this is done, the body can be screwed to the flange and the hermaphrodites again brought into use to draw the flange the parallel width from the body. The inside of the flange can be cut out with either a jig- or a pad-saw Making and fixing the top flange is a simple matter, which it is unnecessary to explain. Usually a job like this has fitting strips, but they need not occasion much trouble. They should be got out as segments broader and thicker than required. Slippers or wedges can be inserted at the ends to raise the segments from the flange, while hermaphrodites are used to draw a line on them parallel to the flange. The segments can then be finished by saw and spokeshave, and gauged to a thickness. It is advisable to screw them in position and draw the diameter on the face. They can then be unscrewed and finished off, and replaced. The pattern can now be sandpapered, and any ribs or bosses and fitting strips screwed on.

The business of Clark's Machine Tool Company, Limited, of Luton, has been taken over by the Luton Tool Company, Dunstable Road, Luton.

Some Tests for Foundry Sands and Their Practical Application.*

By W. WEST, A.M.I.Brit.F.

Scope of Work.

Many excellent articles on the subject of foundry sands have recently appeared in various technical journals, which give the broad lines on which research is at present being carried out. As a metallurgist, the author follows the progress with great interest, but it is now proposed, in a simple way, to deal only with the basic principles upon which sand mixtures should be built, demonstrating them by a few practical tests whenever possible, confining the subject more particularly to the difference in properties required of sands for the iron foundry and those used in the steel foundry.

The problems of the iron foundry are not nearly so pressing as those of the steel foundry, and the cause is solely due to the higher temperature of the steel. The average iron foundryman fails to realise this immense difference, for troubles such as blowholes, scabbing, burning-on, cracks due to contraction, which are periodic visitors to the steel founder, only occasionally, and then in a mild degree, come the way of the iron foundry.

Sands, therefore, which are used for iron and non-ferrous moulding, cannot be used at all in the casting of steel, for the reason that they are insufficiently refractory and, on coming in contact with the molten metal, fuse under the high temperature and become incorporated in the surface of the steel.

Influence of Process on Sand.

It becomes, therefore, a great necessity to understand the principles of sand-mixing for the various branches of founding, and the peculiar demands of each branch. In the author's experience, a great part of which has been associated with the manufacture of steel castings, he has found that steel from the different processes of manufacture demand different properties of the moulding sand to withstand its own peculiar action. Steel prepared in Tropenas converters shows the greatest tendency for burning-on, electric steel less so, and, least of all, open-hearth metal.

Undoubtedly the "bite" of converter steel is due to the very hot metal obtained, combined with the possible action of occluded gases. However, there is sufficient evidence to show that, while a great number of sands are available for the iron foundry, improvement can always be obtained by intelligently using the various kinds to obtain consistently good results. It is proposed therefore to give the broad principles of sand-blending.

Composition as Indicated by Ultimate Analysis.

Many of the physical properties which characterise various sands used for moulding can be directly attributed to the composition, so that, while an analysis of a consignment of sand will yield little or no information to the foundryman, it is a contributory factor to the proper understanding as to the behaviour of a sand under practical conditions and the final results to be expected.

As is generally known, sand is formed by natural decomposition of granite rock, through long periods of time, and is composed of three distinct substances:—

Quartz.—This is simply silica or pure sand, varying in grain size, and in shape angular and round. It gives refractoriness to the sand.

Clay.—Clay is aluminium oxide and silica, combined together, forming aluminium silicate, with which is associated oxide of iron hydrated, which means combined with water. It is the constituent responsible for the bonding quality.

Feldspars.—These are the non-decomposed parts of the rock, containing sodium, potassium and aluminium oxides, lime and magnesia, each combined with silica to form compound silicates.

These reduce the heat-resisting quality and have a fusing influence on the sand.

The result of chemical analysis is usually stated in the following "percentage of" terms:—Loss on ignition: Silica (SiO_2), alumina (Al_2O_3), oxide of iron (Fe_2O_3), lime (CaO), magnesia (MgO), and alkalies (*a*) sodium oxide (Na_2O) and (*b*) potassium oxide (K_2O).

It is not always to be understood that a high silica content shown by the analysis is definite proof that the sand is of a refractory nature—though this is true with sea-sand and other unbonded sands—but rather because alumina (aluminium oxide) and silica combine together, forming clay; the analysis reports the total percentage of silica present, which is only partially free in the form of quartz, the constituent which gives refractoriness.

Similarly, it is misleading to suppose that the amount of alumina, as shown by the chemical analysis, represents the total bonding property of the sand, for much of it is demanded for the formation of feldspar, which, as stated, contains silica, alumina, soda, potash, lime and magnesia, combined together in natural order and proportions.

The occurrence of oxide of iron in the hydrated form, a colloidal (or jelly-like) form with water, is now rightly considered as holding a relation to the bonding quality, and this can be determined. The percentage of iron oxide as given by the analysis does not give the exact influence of this as a bond, for a sand having 5 to 6 per cent. simply as iron oxide may have practically no bonding, while that percentage of iron oxide occurring in the colloidal form with other constituents its influence is considerable. One can therefore consider that this influence as a bond may be due to the property of the colloidal iron oxide retaining water in the sand mixture, and thereby giving strength without an excess of silt and clayey matter, which would choke the pores of the mould.

Because of the low fusing-points of lime and magnesia, these constituents should be as low as possible to avoid trouble due to the sand sticking to the skin of the casting. Quantities up to 1.0 per cent. of the combined substances are permissible and will give no detrimental effect.

Sodium and potassium oxides are totally undesirable for the same reason. For example, an undiluted Mansfield sand is not suitable for steel castings, because it contains 2 to 3 per cent. K_2O.

It will be seen, therefore, how important it is to make careful interpretation of a chemical analysis, for it does not in any way give direct clues as to the physical properties of the sand which are recognised as of the greatest importance. It is therefore necessary to consider any analysis in the light of other mechanical and physical tests.

Rational Analysis.

A rational analysis indicates precisely the combination of the various elementary constituents shown by chemical analysis, the degree to which combination has occurred depends very much on the amounts of each constituent present. This so-called rational analysis can be arrived at in two ways. (1) From the ultimate analysis by calculation; (2) by various experiments.

As previously mentioned, the ultimate analysis gives exactly the total amounts of each constituent of the sand individually, and does not offer any direct information regarding the properties of the combined constituents. Now, taking for example a sample of north Yorkshire yellow moulding sand, which has the following analysis:—Silica (SiO_2), 89.31; alumina (Al_2O_3), 6.09; oxide of iron (Fe_2O_3), 1.94; lime (CaO), 0.35; magnesia (MgO), 0.17; sodium oxide (Na_2O), 0.57; potassium oxide (K_2O), 0.34; and moisture, 1.80 per cent.

Of the above, potash, soda and lime are probably present as undecomposed feldspars, occurring in the following combinations:—(1) $K_2O.\ Al_2O_3.\ 2SiO_2$; (2) $Na_2O.\ Al_2O_3.\ 2SiO_2$; and (3) $CaO.\ Al_2O_3.\ 2SiO_2$

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From the atomic weights (potassium (K) = 39, oxygen (O) = 16, aluminium (Al) = 27, and silicon (Si) = 28), that is, the weight of one atom of each element compared with the weight of one atom of hydrogen, compound (1) will have the following relative weight:—$K_2O - Al_2O_3 - 2SiO_2$ 78+16=94, 54+48=102, 56+64=120, which means 94 parts K_2O combined with 102 parts Al_2O_3, so that 0.34 parts found by analysis will combine with

$$\frac{102 \times 0.34}{94} = 0.37 \text{ per cent. } Al_2O_3.$$

Similarly, 057 per cent. Na_2O requires 0.93 per cent. Al_2O_3, and 0.35 per cent. CaO requires 0.63 per cent. Al_2O_3. Therefore, allotting to the sodium, potassium and lime the necessary alumina and silica to produce feldspar, we find there is a balance remaining of 4.16 per cent. Al_2O_3 unused, or is free as bond.

This 4.16 per cent. is present as clay, and has approximately a composition:—

$$Al_2O_3 . 2SiO_2 . 2H_2O.$$
$$54 + 48 = 102 \quad 56 + 64 = 120 \quad 4 + 32 = 36$$

Again using the atomic weights, it is found 102 parts Al_2O_3 require 120 parts SiO_2, 4.16 parts Al_2O_3 require $\frac{120 \times 4.16}{102} = 4.9$ per cent. silica.

Thus 4.90 per cent. of silica is required to combine with 4.16 per cent. of free alumina to form pure clay (or kaolin).

Now the feldspars require silica in their combination as follows:—

K_2O	0.34 per cent.	$\times$ 1.085 = 0.37
Na_2O	0.37 per cent.	$\times$ 1.935 = 1.10.
CaO	0.35 per cent.	$\times$ 2.143 = 0.75.
MgO	0.17 per cent.	$\times$ 3.000 = 0.51.
		2.73.

Therefore the silica required for combination with alumina and feldspars totals 4.90+2.73 = 7.63 per cent. silica. Subtracting this amount from the silica found by analysis, 89.31 – 7.63 = 81.68 per cent. quartz free to act as refractory.

Now, in the formation of the clay, two molecules of water are required, so calculating in a similar way, we get:—

102 parts Al_2O_3 requires 36 parts H_2O.

4.16 parts Al_2O_3 requires $\frac{36 \times 4.16}{102} = 1.46$ parts of water.

Subtracting from the amount shown by analysis:—1.80 – 1.46 = 0.34 remaining for the oxide of iron. Therefore the analysis shows a clay bond containing:—4.90 per cent. SiO_2, 4.16 per cent. Al_2O_3, and 1.46 per cent. water, making a total of 10.52 per cent. total clay bond. The rational analysis of this sand thus becomes:—81.68 quartz, 10.52 clay bond, 2.28 iron bond, and 6.09 per cent. feldspars. Further calculation is not necessary, for these items give the information useful to the foundryman.

The percentage of quartz immediately gives the approximate silica content, which information is of great value in selecting sands for steel castings work, where refractoriness is extremely vital. It is the percentage of free silica or quartz in a sand which gives the property to withstand heat. The clay substance can also be determined by the bond of absorption method, but the amount given by the rational analysis will, if used with caution, give assistance to a satisfactory conclusion.

Direct Methods of Ascertaining Sand Values.

Schultze used an apparatus to determine approximately tho percentage of quartz and clay which we have just calculated. It consisted of taking a weighed quantity of sand, which is introduced into a conical vessel in small portions at a time. The clean sand falls to the bottom, and, by suitably regulating the outflow of water, only the clay which is carried upward by the excess of water passes away, together with a little of the finest sand particles. The washing of 50 grammes of sand should be complete in about 3 hours, if the funnel be periodically used as a stirring rod; then the residue is carefully washed out, dried, and weighed, to give an approximate idea of the silica sand present.

Another simple test to ascertain the proportion of the constituents in a sand, by measure, instead of by weight, is to half fill a stoppered graduated cylinder with the sand, add water to the 500 c.c. mark, and shake until all the lumps are broken down; then allow to settle. The heavier grains are seen settling to the bottom, and the layers of sand get gradually finer until on the top of these a depth of mud, due to the clay, is noticeable, and above that clean water.

Refractoriness.

Little remains to be said on this question, but the one basic fact holds good that the higher the percentage of quartz, the greater will be the resistance to high temperatures. It will readily be noticed, therefore, that for steel casting refractoriness of the sand is essential—in other words, the quartz content must be higher than the amount present in a sand for iron or non-ferrous casting.

The following tables give a comparison of chemical and rational analysis for iron and steel castings:—

Table I.—*Suitable compositions for iron material.*

Material.	Percentage for light work.	Percentage for medium work.	Percentage for heavy work.
Silica	82.0	85.0	88.0
Alumina ..	9.0	8.0	6.5
Iron oxide ..	4.0	2.5	2.0
Lime	0.5	0.5	0.5
Magnesia, Soda .. Potash ..	Low as possible. Each constituent under 0.5 per cent.		
Rational Analysis.			
Quartz	73.3	75.5	80.4
Clay bond ..	17.1	15.0	10.0
Feldspars ..	5.1	6.6	6.6

Table II.—*Showing suitable compositions for steel castings.*

Material.	Percentage for light and medium work.	Percentage for heavy work.
Silica	89.30	92.80
Alumina ..	6.17	3.92
Iron oxide ..	2.13	2.48
Lime	0.98	0.50
Magnesia, Soda .. Potash ..	0.50	0.50
Rational Analysis.		
Quartz	82.10	88.4
Clay bond ..	12.10	8.6
Feldspar ..	4.80	3.20

Salt Objectionable.

The presence of salt is extremely objectionable, as the sodium it contains forms very fusible silicates. Sea-sands are therefore not good for foundry use unless they have been previously washed. The degree of refractoriness which must characterise any moulding sand, using this term in the sense of facing sand, must be considered according to circumstances, *i.e.*, kind of metal and method of moulding, whether green, skin-dried or dry sand.

Facing Materials.

The specific use of this term would include all those materials which are used to obtain a smooth surface to the exterior of the casting, and yet at the same time will easily "peel off" after cooling down. The true function, therefore, of facings such as plumbago, blacking, graphite, etc., is in effect to increase the refractoriness of the sand.

Facing Sand.

The general practice in most foundries is to use two kinds of sand, one being a specially-prepared facing and the other backing sand mixed from the floor, so that, after stripping the casting from its mould, it is generally supposed that there is sufficient good facing-sand left unaffected by the heat of the metal that will strengthen the sand pile and thereby render any further addition of new sand unnecessary.

In the iron foundry the philosophy of coal additions rich in gas and finely powdered is still a matter as yet unsettled from a technical point of view, but practical experience has shown that in proportion of one part of coal to ten parts of sand, where little of tho coal comes into close proximity of the metal, there is little chance of the gases evolved blowing into the metal.

On the other hand, what actually takes place can be summarised in two ways. Either the gas

formed from the fine coal by contact with the hot metal acts as a cushion between the mould and the flow of the metal, and in this way prevents erosion of the sand, or the volatile hydrocarbons come off from the coal as smoke, and will eventually burn away or be taken up by the metal itself.

It is therefore of importance that the coal dust used should be readily decomposed as the metal flows over it; for this the coal must have a high percentage of volatile with *low sulphur and ash content.*

One can be reasonably satisfied if the ash content does not exceed 10 per cent. and the volatile matter is at least 35 per cent. Another property of the coal dust is its degree of fineness, varying grades of sand requiring various degrees of fineness. A light casting would need a superfine quality to obtain a pleasing result, while with heavy and medium work a coarser grade would be better to assist the venting qualities of the mould.

It is generally accepted that for heavier work more coal dust should be used in the facing, but for reasons of economy, and also that excessive additions result in a bad skin effect, the proportions are made according to the thickness of the casting, and vary from one part of coal dust to 17 parts sand for light castings to 1 part coal dust to 8 parts sand for heavier work.

Blackings or Graphitic Facings.

The primary function of the facing which comes next to the metal is to give the skin of the casting a fine smooth finish. Graphitic facings can be divided up into three classes, each consisting respectively:—(1) Graphite, (2) plumbago, and (3) blacklead. Graphite is unquestionably the most important of the three, for, owing to its natural greasy nature, its high-refractory quality, together with the flakey structure, it is admirably suitable for covering surfaces. However, for commercial purposes it is mixed with other constituents to reduce the resultant cost, and yet achieve a similar result.

Foundrymen are thereby offered all varieties of facings, from the flakey variety down to the material totally lacking of the chief character of graphite—greasiness and flakiness—and is called graphitic anthracite. Adulteration is made by the addition of soapstone, coke, coal, or anthracite to cheapen the mixture.

On what basis then can we establish any rule for guidance as to the particular grade that can be used? All good blackings are composed more or less of graphite; the more it contains, the better the casting will peel from the mould, whether used on green sand or loam moulds. However, care should be taken to consider the size of casting with the thickness of the metal and the degree of heat at which the metal must be run.

For light castings, plumbago has given excellent results, but as the casting becomes heavier and thicker, it becomes necessary to have a facing better able to withstand the bulk of metal and the casting temperature, and to this end various additions are made, differing in each and every foundry. For large work plumbago and mineral blacking, in equal quantities, is used, while round the runner, where the hot metal enters, plumbago, with additions of fireclay or other refractory material, will assist the facing to resist the action of the heat.

It should be emphasised that foundrymen should be on the *qui vive* for adulterations in the blackings which they buy. The preparation of a suitable specification for graphitic and mineral blackings is desired, so that the manufacturer and the foundryman might be protected. When pure, plumbago will contain about 100 per cent. carbon, with very small amounts of ash; from this it varies to 60 per cent. carbon and 40 per cent. ash, and still retains some of the desired properties. In this way it can be discerned that paying for silica or sand at graphite rates is a factor to be avoided.

Mineral Facings.

Soapstone is probably the most well-known of the mineral facings, and carries its name because of the soapy feeling, caused with the high percentage of magnesia which it contains, in the form of silicate of magnesia. This material, however, owing to the mineral compound it contains being fusible at high temperatures, is unsuitable for heavy work, but gives satisfactory results with thinner castings.

Bonding Quality.

Unquestionably, there is no property of moulding sand so important to the foundryman as bonding, for it is of great consequence that copes shall not drop or the surfaces be cut by the stream of molten metal. It becomes, therefore, a necessity to establish some simple means whereby sand-heaps, or consignments of fresh sand, can be periodically checked.

Dye Absorption Test.

Another point of importance is that the more and "fatter" the clay substance, the stronger is the sand, but the venting power decreases proportionately owing to the closing up of the pores between the quartz grains. The test of the bonding power is a very simple one. Fat clays have a greater power for absorbing dyes than the "lean" ones, and this property is used for the basis of determining the bonding power. An aniline dye of great "brilliancy" is taken in given quantity, dissolved in water, and a given weight of sand added. After agitating sufficiently long to give a perfect mixture, the material is allowed to settle until a clear solution remains. The lighter the colour, the greater the dye absorption, and hence the better the bonding power. Comparison is made with a standard solution of the dye itself, and thus a basis of valuation of the bonding power is arrived at.

Strength of Moulding Sands.

This is intimately connected with the amount of clay present, its quality, and the degree to which this bond covers the quartz grains. All successful bonds, whether natural or artificial, belong to that class of bodies called colloids—a satisfactory definition is not desired here, but the best idea of them can be obtained by mention of some of the chief ones, gelatine, albumin, tannin—and stand in definite contrast to crystalloids, of which common salt and copper sulphate are typical examples. Some mention has been made of sands which contain fair quantities of iron oxide, known as ochre sand, or red sands. This oxide of iron is in a colloidal form, which promotes a roughness round the quartz grains, with consequent greater ability of the clay to adhere to the quartz surface.

The amount of water with which a moulding sand is tempered assists the clay bond to cover the grains and to hold them together. In the steel foundry, when green-sand moulds are in vogue, it is of the utmost importance to maintain constant the amount of moisture, as too little means bad lifts and scabby castings; too much may result in gassy castings. The moisture of the sand for green or skin-dried work should approximate between 4 to 5 per cent.

Milling the sand has a wonderful effect of strengthening a sand by bringing into intimate mixture the silica grains and the clay bond. The author's experience has proved that a naturally bonded sand gives better bonding qualities to a sand, and more evenly distributed than additions of fireclay to a siliceous sand.

For the rough idea of the strength of a sand the foundryman has a rule of grabbing the tempered sand, balling it up, and breaking the lump. It may be interesting perhaps to show what has been done by way of comparing the strength of moulding sand when tempered and rammed up into specimen. A mixture of sand is placed in a core-box and struck off evenly with the hand or a flat board, and the errors of unevenly tamping the test bar eliminated by pressing the sand in the core-box by means of a special compressing block. By this means it is possible to compress the volume of sand, which initially occupies a space of 1 in. × 2 in. × 12 in., into a solid core 1 in. × 1 in. × 12 in. The core is then gently pushed towards the end of the base block until it breaks off; the length of the portion of bar breaking off is the measure of the bonding strength of the mixture.

For the purpose of easy comparison, a core which projects over the plate 3 in. before breaking can be stated to have a plasticity of 100. By this method a comparison of various sands is possible, or a simple check can be made on the sand heaps from day to day.

Mechanical Grading.

In the casting of metals if the gases which are liberated cannot escape through the mould they become imprisoned in the cooling metal and produce blow-holes. A moulding sand therefore must be open enough to carry away these gases. The mechanical composition of the sand is therefore of great importance.

The grading is carried out by the use of a set of sieves of given mesh sizes, the sand being previously dried before passing through the sieves. The figures obtained are reported so:—

Coarse sand.	*Medium sand.*	*Fine sand.*
> 0.5 mm	> 0.25 < 0.50	> 0.1 < 0.25

Coarse silt.	*Fine silt.*	*Clay.*	*Total sand grade.*
> 0.05 < 0.10	> 0.01 < 0.05	< 0.01	> 0.1 mm.

The ideal sand would be made up of a uniform grain size and round. It will be readily understood that small grains pack between large ones, whether round or angular, and this means the venting quality is to a great extent reduced.

The mechanical analysis of the yellow moulding sand, the rational analysis of which has been previously calculated, figures out as follows:—

V.C.S.	*C. sand.*	*Med. sand.*	*Fine sand.*
> 1 mm.	> 0.5 mm. < 1.0 mm.	> 0.25 < 0.50	> 0.1 < 0.25
—	0.5 %	1.5 %	74.3 %

Coarse sand.	*Fine silt.*	*Clay.*	*Total sand.*
> 0.05 < 0.10	> 0.01 < 0.05	< 0.01	> 0.1 mm.
7.8 %	2.6 %	13.3 %	76.3 %

According to the standards previously given for rational analysis, this sand would be suitable for use in heavy iron moulding, but the results of mechanical grading proves its unsuitability, for the large percentage of fine sand classifies it as a non-ferrous moulding sand.

Dr. Boswell, in his excellent book on refractory sands, states that when the separate grades of a naturally bonded sand are subjected to chemical analysis a progressive increase or decrease in percentage of the various elements is seen to accompany the grading. The silica content, as one would expect, falls regularly in percentage as the silt and clay grades are approached. All the other constituents increase, particularly the alumina and iron oxide.

In conclusion, as a practical test, the mechanical grading gives a very good idea to the foundryman of any sand, and its suitability for a particular class of work. Combining the results of each analysis, chemical, rational and mechanical, it can be confidently stated that where these are understood, even one might say, in a crude way, a distinct progressive step has been won, and is precursory to many more which science can offer to those in control of founding, when applied to foundry matters in a practical way.

Moulding Sand Investigation.

The American Bureau of Standards is conducting a series of tests to discover a sand with 100 per cent. permeability. The advantage of finding a perfectly permeable sand or one which approximates perfect permeability is obvious. Having a standard sand with a known permeability, the suitability of every moulding sand could be expressed in percentage of a sand found to be 100 per cent. permeable. To accomplish this result, several sands have been investigated. One commercial grade of sand, which is a very pure silica sand of a fairly uniform degree of fineness, has been found on a number of tests, both dry and with as high as 4 per cent. of moisture to be 100 per cent. permeable. Further tests are being made to determine its colloidal matter or any other substances which might affect its permeability.—"Iron Age."

Zinc Industry of Northern France.

The Commercial Secretary at Paris (Mr. J. R. Cahill) has forwarded to the Department of Overseas Trade the following report on the zinc industry of Northern France, which recently appeared in the "Nord Industriel."

The report states that in 1913 France produced 67,890 tons of zinc, of which 47,440 tons, or 69.8 per cent., were supplied by the Departments of the Nord (37,489 tons) and the Pas-de-Calais (9,951 tons). The only other district where zinc was produced on a large scale was the Department of the Aveyron (20,450 tons), where the important works at Viviez were operated by the Société de la Vieille-Montagne. The three zinc works in the Department of the Nord were at Ruby (Société Asturienne des Mines), with 33 ovens and 6,600 crucibles; Montagne (Société Franco-Belge), with 14 ovens and 240 crucibles; and Saint-Amand (M. Bloch), with 12 ovens and 40 crucibles. In the Pas-de-Calais the "Société de Malfidano" operated works at Noyelles-Godault, near Dourges.

All these establishments were occupied and damaged by the Germans during the war. French output of zinc would have fallen by 75 per cent. if the "Société Asturienne" had not created works at Rochefort with a capacity of 6,000 tons of metal, and the "Société Nouvelle des Zincs purs" works at Salindres, in the Department of the Gard, with a capacity of 1,200 tons.

The work of reconstruction, which began after the war, is now virtually completed. Even in 1921 the three works of the Department of the Nord produced 11,768 tons of metal.

French potential output has been considerably increased, not only by the creation of the above-mentioned works at Rochefort and Salindres, but also by the enlargement by the "Société de la Vieille Montagne" of its plant at Viviez, where, in 1916, it installed a new establishment capable of producing 8,000 tons of zinc a year.

It may be estimated that France will be able to produce 100,000 tons of metal, whereas before the war she consumed only 78,150 tons. It is true that there has been a remarkable development of the brass industry, and that before the war France imported large quantities of crude and rolled zinc. Her imports amounted to 40,000 tons of metal, of which Belgium supplied 85 per cent. She was also under the influence of the Metallgesellschaft, of Frankfurt, and the Vieille Montagne, which hindered the expansion of the French zinc industry. Yet even then France exported 3,000 tons of worked zinc, a quantity which could be increased in the future.

The necessary supplies of zinc ore are available. The output of French mines, situated principally in the Departments of the Gard and the Hautes-Pyrénées, could be increased from 46,500 tons in 1913 to 60,000 tons. The ore produced in North Africa could also be reserved for France, which in 1913 received only 13,000 tons out of 112,500 tons.

The danger to the zinc industry of the two Northern Departments lies in the competition of the works in the Aveyron and the Midi and in the development of the electrolytic process, which is making great progress in the United States of America, and is favoured in France by the schemes for the more extensive utilisation of water power. The "Société Vieille Montagne" has already harnessed a fall of 4,000 h.p. in the neighbourhood of its works and acquired rights over another fall close by. Similarly, the "Société de Penarroya" has installed a hydro-electric station of 15,000 kw. at Saint-Lary on the Neste d'Aure, and applied for another concession on the same river in the vicinity of the zinc ore deposits of the Haute-Garonne.

The whole question of the future success of the zinc industry in the North depends on whether they can produce the metal by the electrolytic process at a moderate cost. The works in that district suffer from the high cost of transport of the ore from the mines, and they should endeavour to obtain a reduction in the railway rates from Dunkirk, Calais and Boulogne.

The late Mr. F. Espir, metal merchant, of 3, East India Avenue, London, E.C.3, left £26,468.

Company News.

Parman & Butler, Limited.—Capital £1,000 in £1 shares. Brassfounders. Directors: W. F. Butler, W. E. Parman and H. Walter.

Thermal Engineering Company, Limited, 17, Calabria Road, Highbury, London.—Capital £1,000 in £1 shares. Director: A. R. C. Winnis.

William H. Peregrine & Company, Limited, Walmersley Ironworks, Walmersley, near Bury.—Capital £2,000 in £1 shares. Manufacturers of machinery.

"M.P." Company, Limited.—Capital £12,000. Founders, engineers, etc. Permanent directors: H. J. Newton-Clare, T. Powell and W. S. Newton-Clare.

West Vale Brass Company, Limited, Maude Street, West Vale, near Halifax.—Capital £6,000 in £1 shares. Directors: H. Hinchcliffe and J. W. Gaukroger.

William Gilpin, Sen., & Company (Axles), Limited, Howard Road, Hill Top, West Bromwich.—Capital £100 in £1 shares. Axle manufacturers, etc. Secretary: F. E. Francis.

John I. Thornycroft & Company, Limietd.—Dividend, 3 per cent. on preference and participating preferred ordinary; no distribution on ordinary; brought forward, £55,747; carried forward, £60,758.

Blyth Shipbuilding and Dry Docks Company, Limited.—Profit, less depreciation, £22,697; brought forward, £3,307; available, £26,004; debenture interest, £7,686; final dividend, 9d. per share, making 1s. 3d. per share; carry forward, £6,885.

National Heating Company, Limited, 181, Queen Victoria Street, London, E.C.—Capital £2,000 in 500 1st cumulative preference shares of £1 and 12,000 ordinary of 2s. 6d. each. Engineers, etc. Directors: C. E. Hodge, H. Sandford (permanent joint managing directors), and Mrs. E. Sandford.

Blaenavon Company, Limited.—Debenture stock interest, £9,229; loss for year, £55,301; loss on coal sold to workmen, £13,179; adverse balance brought forward, £1,319 transferred from reserves and renewals funds, £5,000; one year's dividend on preference shares, £3,000; debit balance, £67,800.

Poyser's Patents (1922), Limited, Challenge Works, Dale Road, Matlock, Derby.—Capital £5,000 in £1 shares (3,000 6 per cent. cumulative preference), to acquire the business of engineers carried on by Poyser's Patents, Limited. Directors: J. Holmes (chairman) and G. W. Poyser. Secretary: J. Holmes.

Dorman, Long & Company, Limited.—Profit, £160,368; brought forward, £239,487; total, £399,856; interest on debentures, £35,684; interim dividend on 8 per cent. preferred ordinary shares, £60,000; final ditto, £60,000; directors' fees, £3,000; general reserve account, £40,000; carried forward, £201,172; ordinary dividend passed.

Shotts Iron Company, Limited.—Surplus, £4,230; debenture interest, £2,636; interim dividend on preference, £2,024; depreciation, £26,090; £25,000 taken from contingencies account to meet loss through depreciation of stocks; brought forward, £57,634; ordinary dividend, 7½ per cent., free of tax; carry forward, £44,696.

Deaths.

Mr. F. Algar, a partner in the firm of F. Algar & Company, iron merchants, of 7, Waterbeer Street, Exeter, died recently.

Mr. J. C. Doyle, who died suddenly at Carlisle recently, at the age of 66, was formerly managing director of Cowan, Sheldon & Company, Limited, crane manufacturers. He resigned in 1920, but remained a director of the company.

Mr. J. H. Buckley, director, general manager, and secretary of the Renishaw Iron Company, Limited, Renishaw, died suddenly recently at the age of 55. He had been chairman of the Renishaw Iron Company for 18 years, and a director since 1914.

Mr. John Gower, senior partner of John Gower & Sons, engineers and boiler makers, Elston Road, Bedford, died on November 6, aged 77. After being for some time in the service of J. & F. Howard, Limited, engineers, of Bedford, he started in business on his own account about 50 years ago. The business will be carried on as usual by the remaining son and partner, Mr. F. P. H. Gower.

INDIAN IMPORTS OF CAST PIPES AND FITTINGS.—The total imports during the first half of the statistical year ending September 30 fell from 60 to 29 lakhs. The British share was reduced from 39 to 20 lakhs, and that of America from 20 to 6 lakhs, whereas other countries increased their proportion from 1 to 3 lakhs.

Gazette.

The Ernsmore Engineering & Tool Company, Limited, are being wound up voluntarily, with Mr. H. Harris, 4, East Circus Street, Nottingham, as liquidator.

The first meeting of the creditors and contributories of the London Drop Stamping Company, Limited, 40, Hythe Road, Willesden, London, N.W., will be held on December 15.

Messrs. W. Marshall and A. Wilkinson, trading under the style of Marshall & Wilkinson, Denton Road, Audenshaw, engineers and pattern makers, have dissolved partnership. Mr. A. Wilkinson continues.

The partnership heretofore subsisting between Messrs. A. J. Baker and B. Meanley, iron and steel merchants, Lloyds Bank Chambers, Smethwick, under the style of A. J. Baker & Company, has been dissolved.

The Sheffield Steel Products, Limited, have obtained Orders of Court, dated November 6 and 14, for the appointment of Sir William Barclay Peat as receiver and manager of the properties of the following companies:—Eagle Plate Company, Limited, Templeborough Works, Sheffield; Armstrong, Stevens & Sons, Limited, Birmingham; Moses, Eadon & Sons, Limited, Mowbray Street, Sheffield; Oxley Bros., Limited, Templeborough Works, Sheffield; Joseph Peace & Company, Limited, Rutland Road, Sheffield; Steel Stampings, Limited, Cookley, near Kidderminster; W. K. & C. Pearce, Limited, Eagle Works, Sheffield; Hemmings, Limited, Templeborough Works, Sheffield; Boswell, Hatfield & Company, Limited, Templeborough Works, Sheffield.

The names of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved:—Aeronautical Engineering Company, Limited, Aero Sheet Metal & Engineering Works, Limited, Anderson's Shipbuilding & Repairing Company, Limited, Chelsea Precision Tools, Limited, Clutchnut Engineering Company, Limited, Expert Metal Workers, Limited, Gerrard Engineering Works, Limited, Ingate Engineering Company, Limited, International Electrical & Mechanical Supplies, Limited, Lattimer Engineering Company, Limited, Lubros Engineering Company, Limited, Ostroyd Company, Limited, Slough Metal Company, Limited, Southern Shipbuilding & Engineering Company, Limited, South Wales Ferro-Concrete Shipbuilding Company, Limited, T. W. Field Engineering Company, Limited, United Electrical Works, Limited, Warstone Engineering Company, Limited, Western Marine Motors, Limited, and the West Ham Engineering Company, Limited.

Personal.

Mr. A. H. Fellows has been elected honorary vice-president of the Stephenson Locomotive Society.

The late Mr. J. F. Haeberlein, ore merchant, of Whittington Avenue, London, E.C.3, left £67,699.

Mr. H. S. Deacon, managing director of Cryselco, Limited, Kempston Works, Bedford, is retiring at the end of the year.

Mr. Robert Dumbleton, of Eckington, has been appointed secretary (pro tem.) of the Renishaw Iron Company, Limited.

The late Mr. G. Whitfield, head of McFarlane & Whitfield, rivet manufacturers, Atlas Works, Dunston-on-Tyne, left £14,540.

The late Mr. W. B. Lloyd, founder of Lloyd & Son, Limited, iron founders and metal merchants, of Woolwich, left £13,304.

An interesting ceremony took place recently, when Mr. John Cross and Mr. J. J. Richards, respectively managing director and secretary of Messrs. Wm. Cross & Sons, Lyng Foundry, West Bromwich, were the recipients of a silver salver and a tea and coffee service from the employés of the firm as an appreciation of the way in which they had managed the affairs of the firm during their 50 years' service.

Mr. Thomas Wilkes, managing director of Wilkes, Limited, Grand Junction Works, Darlaston, recently attained his 80th birthday, and to mark the event the employés of the firm have presented him with a handsome timepiece and pair of bronzes. Mr. L. C. Marsden (secretary of the company) also handed to Mr. Wilkes a framed photograph of the staff. Mr. Enoch Wilkes (chairman of the directors), who presided, referred to the long experience Mr. Thomas Wilkes had had in the bolt and nut trade. His experience probably went further back than that of anyone who at present lived in Darlaston.

IRON AND STEEL MARKETS.

Pig-iron.

The near approach of the end of the year, as usual, has had a quietening effect upon movements in the pig-iron markets, and few, if any, developments can now be expected until the termination of the holidays. Reports, however, on the whole, as to the prospects of the trade in the New Year are fairly favourable, the home demand evidencing a steady expansion, consequent mostly upon a healthy revival in the engineering and shipbuilding industries, while the numerous huge schemes of reconstruction are also contributory factors in stimulating consumption of material both at home and abroad. One of the few exceptions to the general conditions is the Scottish pig-iron industry, where smelters are expecting a quiet time for the remainder of the year. Clydeside representatives of the iron trade read with feelings somewhat akin to envy the reports of continued improvement in the industry on the other side of the border, but, unfortunately, the Scottish shipbuilding industry is still very far from it should be, and until more activity materialises in this section it cannot be expected that the iron and steel works here will be busy. In the Midlands the recent reduction in railway transport charges has, so far, had no effect upon pig-iron quotations, smelters stating that, though acceptable as an instalment, the amount saved—2s. per ton—is insufficient to permit of any concession in prices, which for a long time past have been unprofitable to makers. In the Birmingham market, however, business was rather more difficult to close, but there was nothing really discouraging in the current conditions, which suggested that the enlarged demand for iron is maintained and that smelters may look forward to steady trade on the recent scale, with some prospect of further expansion. In some cases forge iron was 1s. up. Very encouraging reports are in circulation concerning engineering and wagon building, from which improved orders are being received. On Tees-side there is undoubtedly an improvement in the home demand for Cleveland foundry iron, and this can be said in spite of the disposition, always evident at this period of the year, to cut down requirements in view of stock-taking. The general tone is certainly healthier, and this will probably be more fully borne out at the turn of the year. Meanwhile, makers have but little iron to spare, notwithstanding recent expansions in the output, for the bulk of the additional make is going direct into the steelworks. Export business continues to be handicapped by the exchange difficulties, but moderate parcels are changing hands and connections are maintained. There was some fresh American inquiry for the standard quality last week, but any further sustained demand from that quarter is not now generally expected. Another blast-furnace is about to be put in for basic steel purposes. While prices are nominally unchanged at last week's levels, there is an inclination to make some concessions against suitable business. Thus, No. 1 and silicious could now probably be done at about 95s. 6d., compared with a recent figure of 97s. 6d., and No. 3 G.M.B. is obtainable at about 91s. 6d. No. 4 foundry is easy at 87s. 6d., and No. 4 forge at 82s. 6d.

A strong and healthy tone characterises the hematite pig-iron market both on the East Coast and Cumberland. The improvement in the steel trade position is reflected in the increased home demand for hematite in Sheffield, South Wales and other centres, and the outlook for home industrial requirements is certainly much better than at any previous period this year. Substantial forward sales are being made for the first quarter of next year, and makers for the most part are already very comfortably placed, order books being the best evidence of a return of trade confidence. Prices are firmly held. East Coast mixed numbers are quoted at 93s. 6d., with No. 1 6d. to 1s. per ton more. Prices for Cumberland and North Lancashire qualities are unchanged, the current quotation for Bessemer mixed numbers ruling at 105s. to 110s. per ton, delivered Glasgow or Sheffield.

Finished Iron.

The position, as regards finished material, has undergone little change since last reported, but a distinctly more hopeful view of the outlook is entertained in trade circles, where the opinion is now strongly held that the coming year will witness an early revival of business in most iron manufacturing departments. A substantial basis for a more optimistic outlook in the trade is found in the increasing activity in the wagon and engineering industries, which have been very depressed for some time, and their improvement must be reflected in the demand for finished goods. Some trouble is still being experienced owing to keen quotations for imported Belgian iron, but these are more effective as bargaining advantages than from any other point of view, inasmuch as the period required for delivery is somewhat extended, and buyers will not commit themselves so far forward. The remarkable steadiness of prices for so long a period is confirmatory evidence of this. It is satisfactory to learn that the foundry trade will also benefit to a substantial extent by the revival of business in other branches, already indicated, the demand for building castings especially having been adversely affected during the past year by the general depression in trade, which has checked developments in this particular direction.

Steel.

The improvement already noted in various branches of the steel industry is well maintained, although, of course, fresh orders are scarce in volume at a period of the year when stock-taking is in near contemplation. Confirmation of this view is forthcoming in the renewed activity developed recently in buying orders for ferro-alloys, that market at present being inundated with inquiries and orders for delivery over the first quarter of next year. There is no doubt that the publicity given to the statements made at the meeting of the Prime Minister and the railway managers concerning renewal and development policies, which will mean the spending of millions, has quickly had a beneficent effect on trade in that it has increased confidence for the immediate future. The chief interest has been ferro-silicon of 45/50 per cent. grade, and some of the largest inquiries for over twelve months have been put out for immediate settlement, with deliveries varied according to individual requirements. An appreciation of makers' price of this alloy of from 5s. to 10s. came into effect almost simultaneously with the railway announcement, and delivered consumers' works prices are now round £11 7s. 6d. per ton. In the 75 per cent. grade demand is still quiet, but the price is firm at £20 per ton for new stock. In the Sheffield steel market the outlook becomes better each week, and transactions are not only more numerous, but on a larger scale. Business in acid billets is distinctly reviving, and a rise in prices may have to be recorded shortly. It is in basic billets, however, that the greatest activity prevails, and the volume of business shows an appreciable increase. Quotations for these have gone up, and are now : £8 15s. for hard, £8 to £8 5s. for medium, and £7 5s. for soft. It is expected that as a consequence of these higher quotations wire rods and rolled steel will shortly be dearer. At present soft basic wire rods cost £10, and hard ditto £11 10s. and £13 10s.

Scrap.

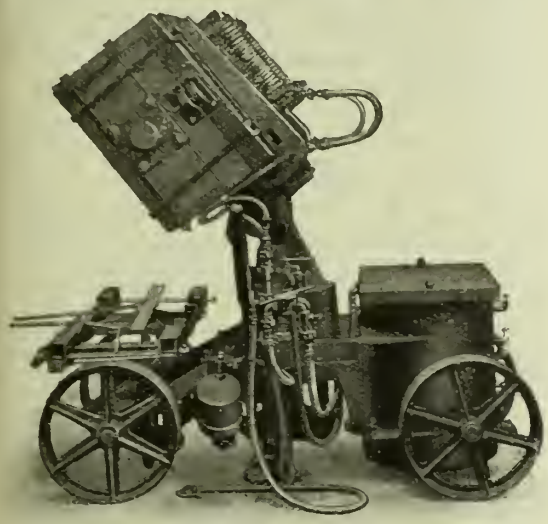
Business in most descriptions of iron and steel scrap has of late taken a distinct turn for the better, the improvement previously noted in the heavier qualities of the latter metal being well maintained, while there is now a more active demand for foundry material, and prices are showing a firmer tendency in other directions. In the Midlands, cast-iron scrap for use in foundries is very firm, and prices have again been increased one or two shillings per ton, especially for the better qualities. At Middlesbrough there is a steadily increasing demand in this district for nearly all descriptions of iron and steel scrap, and prices are showing an upward movement. There is an insistent inquiry for heavy steel scrap, and the price is now fully 71s. per ton. The demand for cast-iron scrap, machinery quality, is improving, and the quotation for this material is now up to 75s. Steel turnings and cast-iron borings are scarce and strong at 55s. to 57s. 6d. Heavy wrought piling iron is stiffer at 72s. 6d., and specially selected heavy forge at 80s. There is practically no demand for bushelling scrap, which is nominal at 65s. All these prices are delivered works.

Metals.

Copper.—Movements in the standard copper market recently have been restricted within a narrow range, fluctuations in values evidencing a quietly steady tendency, on the whole representing little variations of importance from day to day. The home consumptive demand is fairly satisfactory for the end-of-year period, but the disturbance of foreign exchanges still remains a restraining factor in Continental markets. Prices in America remain very steady, the latest quotation being 13.85 cents. The existing immigration laws in the United States, according to the latest reports on the labour situation there, are resulting in a serious shortage of labour being experienced at the mines, and in all big centres of employment. The consequent inability to increase production is to a certain extent offset by the increased imports of copper from South America. Current quotations :—*Cash* ; Wednesday,

(*Continued on page 502.*)

MACNAB & CO.



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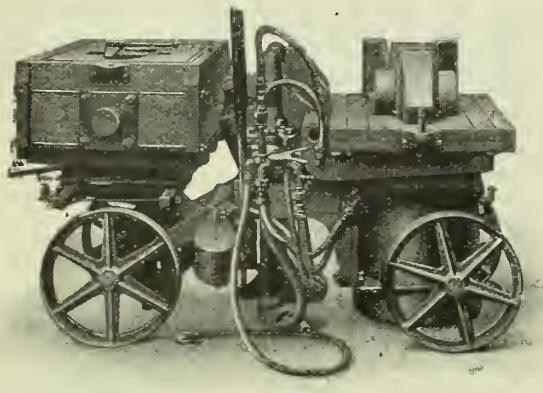

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IRON AND STEEL MARKETS.—*Continued.*

£62 7s. 6d.; Thursday, £62 10s., Friday, £62 10s.; Monday, £62 12s. 6d.; Tuesday, £62 10s. *Three months:* Wednesday, £63 2s. 6d.; Thursday, £63 5s.; Friday, £63 2s. 6d.; Monday, £63 5s.; Tuesday, £63 5s.

Tin.—The market for standard tin has recently developed a more irregular tendency, and variations in values have been inclined to lower levels than those obtaining last month. The statistical position is fairly satisfactory on the whole, showing, according to Messrs. Ricard & Freiwald's report for November, as follows:—Stocks, Landing and Afloat, Europe and America: United Kingdom, stocks in London, 4,001 tons; stocks in other ports, 1,376 tons; total, 5,377 tons; landing and in transit, 335 tons; afloat from Straits, 695 tons; afloat from Australia, 125 tons; total United Kingdom, 6,532 tons. Holland; Banca spot, 2,395 tons; Banca and/or Billiton afloat to Europe and America, 1,545 tons. Continent: Straits afloat, 1,445 tons. United States: Spot and landing, 2,699 tons; afloat, 7,730 tons. Total visible supply, 22,346 tons. Current quotations:—*Cash*: Wednesday, £179 5s.; Thursday, £180 2s. 6d.; Friday, £180 15s.; Monday, £178 17s. 6d.; Tuesday, £175 10s. *Three months:* Wednesday, £180 10s.; Thursday, £181 2s. 6d.; Friday, £181 15s.; Monday, £179 17s. 6d.; Tuesday, £176 15s.

Spelter.—In the market for this metal a sharp recovery has eventuated in current values, an outstanding feature of movements having been a substantial recovery in forward dealings, for which there is a steady demand. According to The American Institute the world's output of zinc for 1922 is estimated at 311,500 tons, excluding America, which compares with the pre-war output, excluding America, of 675,000 tons. The U.S.A. production for 1921 is given as 200,500 tons. Current quotations:—*Ordinary*: Wednesday, nominal; Thursday, nominal; Friday, £40; Monday, £39 10s.; Tuesday, nominal.

Lead.—There is little change to report in this market of late, but a noticeable feature is the weakness of the near and the firmness of the distant position. A rather better demand has been experienced from home consumers, but supplies have been ample to meet all immediate requirements. The forward position, in this respect, is not so satisfactory, as there are no indications at present of increased supplies from any quarter. Current quotations:—*Soft foreign (prompt)*: Wednesday, £25 17s. 6d.; Thursday, £25 17s. 6d.; Friday, £26; Monday, £26; Tuesday, £26 2s. 6d.

Trade Talk.

Some 100 moulders on Tees-side are on strike as a protest against a wage reduction.

Over seven hundred men are thrown out of work by the closing of the Leeds Steelworks for an indefinite period.

The Calphos Electrical Company, Limited, have removed to 70, Victoria Street, Westminster, London, S.W.1.

The Belgian Acieries d'Angleur have booked an order for 5,000 tons of rails and fastenings for the Polish railways.

M. C. Gooding & Company, engineers, formerly of Jubilee Works, George Street, have removed to 38, Keens Road, South Croydon.

The men employed at the Albion Steelworks, owned by the Briton Ferry Steel Company, Limited, have received notices varying from 14 to 28 days to terminate work.

Mr. George W. Martin, consulting engineer, has removed his city office from 5, Great James Street, Bedford Row, to Sentinel House, Southampton Row, London, W.C.1.

Bell Bros. (Manchester), Limited, have transferred their works at Ravensthorpe, Yorks, and their city office at 5, Deansgate, Manchester, to the Calder Ironworks, Denton, Manchester.

James Hargreaves & Sons (Leeds), Limited, have removed their London offices from 6, Broad Street Place, E.C.2, to Finsbury Court (Western Corridor), Finsbury Pavement, London, E.C.2.

The steelworks of the Skinningrove Iron Company, Limited, will probably be restarted this month, after a very long period of inactivity. A third blast-furnace and a battery of coke ovens are also to be put into operation.

A dispute concerning the wages of furnace bricklayers and bricklayers' labourers, which began last February, is officially ended to permit of national negotiations between the employers' and the workers' organisations.

The Blaenavon Company, Limited, state that their scheme of works extensions is almost complete. The principal capital expenditure during the past year has been on the gas cleaning plant and new Ratcau blower and condenser.

The old-established business of Shand, Mason & Company, fire engine makers, of Blackfriars, has been purchased by, and is now incorporated with, Merryweather & Sons, Limited, of Greenwich Road, London, S.E.10.

The wages regulated by the sliding scale under the Midland Iron and Steel Wages Board were advanced 2½ per cent. from Monday, December 4, and the new rate will remain in operation until Saturday, February 3, 1923.

The Vulcan Foundry, Limited, are supplying twelve 4-6-0 type M. class and ten 4-6-0 S.G. class locomotive for metre-gauge lines to the South Indian Railway, and 27 goods type locomotives to the Great Indian Peninsula Railway.

The executive of the Amalgamated Engineering Union met the Engineering Employers' Federation, in London on December 1, to discuss the question of payment for work done on holidays. The conference lasted throughout the day, and at the conclusion it was officially announced that a joint recommendation had been agreed upon, and would be submitted in due course to the constituent bodies of both sides for ratification.

Many of the war-blinded men at St. Dunstan's have been very thoroughly trained as telephone operators, and have successfully filled positions all over the country in this capacity. Five or six of these men are waiting for positions at the present time, and the secretary of St. Dunstan's After-Care Organisation at the Headquarters of St. Dunstan's Work, Regent's Park, N.W.1, will supply information to those able to engage a blinded soldier as telephone operator.

E. Capper Robson & Company, Limited, 1, North Road, Darlington, Durham, announce that the note published in the early part of the month, to the effect that they will in future trade as Robson Refractories, Limited, is incorrect, as Robson Refractories, Limited, are distinctly a separate company. Robson Refractories, Limited, were formed for the purpose of controlling "Cupoline" in this country, the selling rights of which were previously held by E. Capper Robson & Company, Limited, but the latter will continue to trade as E. Capper Robson & Company, Limited, as hitherto.

The general secretary of the National Federated Electrical Association has written to all members of that body instructing them to put into effect the second 5 per cent. reduction on the April, 1921, rates. This follows on an intimation by Mr. Rowan, the secretary of the Electrical Trades Union, that the result of the ballot vote of that union is in favour of accepting the recommendation agreed upon by negotiation. The reduction will take effect on the first pay day following Sunday, January 7, when the rates will be: Grade A, 1s. 9½d. (this rate includes a travelling allowance. No further allowances to be paid except as provided by Rule 9 of the London Rules, dated February, 1920); Grade B, 1s. 6½d.; Grade C, 1s. 5d.; Grade D, 1s. 3⅜d.

Another International Foundry Trades Exhibition.

Arrangements have now been made by the Birmingham Chamber of Commerce, in conjunction with the British Cast Iron Research Association, to hold an International Foundry Trades Exhibition at Birmingham in the early summer of 1924, and every effort will be made to make it as comprehensive as possible. It will be remembered that the Exhibition of 1922 was the first of its kind in this country and was an exceptional success. Steps will be taken to ensure a greater international representation at the 1924 Exhibition, and arrangements will be made to increase the schedule of the Foundry Employees' Competitions, which were so very successful. The Chamber of Commerce are to be congratulated upon their early decision to bring together a further Exhibition to improve the foundry industry.

Growth of the I.B.F.—Over 70 members, associate members and associates were elected at a meeting of the Council of the Institution of British Foundrymen, held in York last Saturday.

The American National Founders' Association are petitioning the President and Congress of the United States for an alteration in the present immigration laws, as they believe there is a grave danger of a serious shortage in foundry labour in the near future.

THE

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Contents.

	PAGE
Foundry Competition	503
The British Cast-Iron Research Association	503
How Quality is Produced under Quantity Production Conditions	504
Chilean State Railway Contracts	506
Determination of Silicon in Pig-iron	506
Contracts Open	506
British Empire Exhibition	506
Layout for Electric Tool Steel Plant	507
Swedish Iron and Steel Production	508
Gating, Feeding and Casting	509
The Treatment of Green Sand Moulding Sand	512
An Apprenticeship Course in Foundry Practice.—XXIII.	513
Birmingham Metallurgical Society	514
American Malleable Castings Association	514
American Methods of Sampling Pig-Iron	515
Book Review	516
Another New American Foundrymen's Association	516
Institution of British Foundrymen	517
Recovery of Molybdic Acid and Preparation of Ammonium Molybdate Solution from Ammonium Phospho-Molybdate	518
The Effect of Special Elements on Cast-iron	519
Blue Constituent in Manganese-Bronze	523
New Installations of Electric Brass-Melting Furnaces	523
Trade Talk	524
Publications Received	524
Patent Abstracts	524
Iron and Steel Markets	525
Deaths	526
Company News	526
Personal	526
Gazette	526

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Foundry Competition.

Iron foundrymen are capable of visualising the competition they receive from other foundries, but it is doubtful whether they realise the inroads which other materials are making into what has been considered their undoubted province. In every section of the trade materials of more recent origin than cast iron are seriously encroaching.

In sanitary ware glazed bricks and earthenware form strong competition. Cast iron cooking utensils are being replaced by aluminium, and earthenware and cast-iron pipes by steel and reinforced concrete. This last material has made tremendous strides, and has stopped the production of many thousands of tons of cast iron for columns and pillars. Steel castings of lighter section, and even drop forgings, form a serious rivalry for cast iron. So one could enlarge *ad infinitum* pointing out how cast iron has been and is being replaced by other material as civilisation progresses. The main materials to be considered are earthenware, where little strength is required, and steel and ferro-concrete, where greater strength is demanded. We purposely included the reference to the march of civilisation, because we desire to put forward that, as all countries have not reached the same stage, there still remains a good market in lesser developed countries for material which commanded a ready sale in Europe some 50 years ago. Producing some of the old-fashioned material by modern quantity-production methods a good market should be found in the lesser civilised countries for domestic consumption. To compete with stronger materials cast iron must be made stronger and so allow of a diminished weight. Obviously, this means research of expensive nature, coupled with propaganda to teach engineers that they can incorporate cast iron of lesser section than has been customary. This dual proposition can only be accomplished by co-operative means, and the only organisation possible is a national one. Fortunately, British foundrymen have had the foresight to provide themselves with an organisation in every way suitable for the purpose. We refer to the British Cast-Iron Research Association. This organisation, after one years' working, can claim the support of nearly 7 per cent. of British foundries. If efficiently conducted it should be of a snowball character and gather weight, but if it lacks the necessary support, the snowball will quickly melt away, to the detriment of British industry. Whilst on this subject we would point out that every foundryman, whether he likes it or not, has to support the Association, as it is Governmentally subsidised on what the Americans term a 50-50 basis. If, however, he desires to get more return for his money than his butcher, he must subscribe directly, the subscription being based on the number of certain specified personnel.

The indifferent position of their malleable industry is being dismissed by British foundrymen with the remark that the Americans have so highly developed the industry that it seems hopeless to expect the British to raise the standard to the plane achieved by the Americans. We would point out that the British boot industry was revived by the introduction of American machinery and methods, and to-day is as flourishing as most industries. Then if boots, why not malleable cast iron. As a final 1922 message to our cast-iron foundrymen readers, we would give this advice: Make yourself *au fait* with all published works on your past, present and possible manufactures and put yourself in position to be immediately advised as to new developments. This will make for a prosperous New Year, more than any expressed wish of ours.

The British Cast-Iron Research Association

At the first meeting of the enlarged General Council held on December 13, at Birmingham, Mr. H. B. Weeks, F.I.C., of Vickers, Limited, Barrow, was re-elected Chairman of the Council; Mr. O. Stubbs, M.I.M.E. (Manchester), and Mr. F. J. Cook (Birmingham) were elected Vice-Chairmen. Both these gentlemen are past-presidents of the Institution of British Foundrymen.

How Quality is Produced under Quantity Production Conditions.

By H. Cole Estep (European Manager of "The Foundry").

(*Continued from page 484.*)

Pyrometic Control.

Nor is the scientific control of the metal, right in the foundry, confined to chemical analysis. For instance, in another foundry cited by Mr. Elliott, pyrometers are being used to determine the temperature of the molten iron at the cupola, in ladles of various sizes, and at various locations in the foundry, with the result that by re-arranging the location of the light and heavy casting floors, altering the sizes of the ladles, and the number of transfers of metal, the quality of the product is being vastly improved. Another foundry, making rolls, is using the optical pyrometer to determine the temperature of the metal as it flows from the furnace. The metal is then held in the ladle until it cools to the exact temperature at which the roll is to be poured. Malleable foundries are also using the optical pyrometer for determining the pouring temperature.

More recently some of these foundries have started to make preliminary chemical analyses of the malleable iron, while it is still in the furnace, as in steelmaking practice, so as to control the composition of the resulting castings more accurately. In a certain steel foundry in America the metallurgist marks the temperature at which the steel shall be poured, on a board which is prominently displayed on the charging floor. The desired carbon content also is indicated on this board. When the heat is tapped out the metallurgist takes the temperature with an optical pyrometer, and, after the metal has been analysed, both the pouring temperature and the analysis is marked up on the board, so that everyone in the shop can see how closely the melter has come to the specifications. This produces a certain amount of competition among the different melters, with satisfactory results. Still other foundries in the United States, making iron as well as steel castings, have been devoting a great deal of study to the electric furnace as a means of improving the quality of metal under tonnage production. In a certain foundry in Cincinnati, the introduction of an electric furnace reduced the defectives of a certain pattern from 35 per cent. to 3 per cent., at the same time increasing the strength of the iron 40 per cent.

It is not difficult in American shops to produce cast iron, to which no steel has been added, under the conditions of chemical control suggested above, with an average tensile strength of over 16 tons per sq. in. Almost any iron foundry metallurgist in the United States, in the better class of shops, has seen many hundreds of heats of iron of 16 to 17 tons strength. These irons are, of course, formulated to fulfil particular conditions, and should not be compared seriously with the product of many jobbing foundries catering to trades in which quality is not a *desideratum*.

Mixing Metal by Analysis.

It has been possible to put the large-scale foundry operations of the United States on an exact basis, largely through the fact that pig-iron is sold exclusively by analysis. No American foundry purchases pig-iron by fracture. Instead the blast furnace furnishes a report showing the analysis of each truck of iron delivered. These analyses are sufficiently accurate for the very small foundries to use them for calculating their mixtures. While many of these foundries do not employ chemists, they almost invariably send samples regularly to outside chemists for analysis. Other small foundries are served by consulting chemists established in different cities throughout the country. These chemists furnish analysis of the product regularly, and also send experts to the foundries, by whom they are employed, to establish and maintain correct melting practice.

Foundries large enough to maintain their own laboratories invariably test all heats chemically and physically. Some of these foundries analyse every truckload of pig-iron as it is received, but it is significant that others have found the blast-furnace analysis to be so correct that they have dispensed with the routine analysis of the pig-iron. All of them, however, test the coke for sulphur and ash, a maximum percentage of each being specified when the coke is purchased.

Besides the routine analysis of raw materials and finished product, the modern foundry chemist is usually busy with research work, in order to improve the quality of his material and standardise the different mixtures, for most foundries use several different compositions of metal and mixtures of iron for the several classes of castings which they make. Grey iron is regularly tested for transverse strength, but as a general rule for tensile strength only in research work. As a rule the engineer specifies the qualities he desires in the castings for the machine or device he is designing. The metallurgist, then, must control the mixture and the cupola so as to produce these results. In other cases the customer provides specifications which the foundry must meet.

The General Electric Company, which has its headquarters at Schenectady, New York, has a number of foundries in different parts of the country, and its procedure for controlling the quality of its castings is perhaps typical of the larger American organisations. At the different works a number of different metal mixtures are used as determined by the metallurgists at the respective plants.

The different grades of castings must meet predetermined transverse tests. For this purpose test bars are cast from every mixture of iron used and tested regularly. While each foundry controls its own mixtures, a general foundry committee composed of the superintendents and metallurgists of all the foundries of the company meets regularly to discuss foundry problems and methods of improving the quality of the iron.

Some Actual Results.

In the automobile industry a large amount of work has been done investigating the characteristics of cast iron and developing methods of laboratory control so that a reliable product may be made under quantity-production conditions. That this work has borne fruit is shown by the records of the Cadillac Motor Car Company. The average cylinder-iron produced by this company, according to H. B. Swan, Superintendent of Foundries, has a tensile strength of 15.5 to 16 tons per sq. in., with a transverse strength on the arbitration bar of 3,500 to 4,000 lbs. The aim in making cylinders is to produce hard barrels of fine-grain-texture, using an iron free from segregation. A cylinder may be perfect and without a flaw as far as leaks, sandholes, blows, etc., are concerned, but if the grain of the bore, after it has been ground to a highly-finished surface, shows under inspection as being open or coarse, the cylinder is scrapped. A portion of the pig-iron used is smelted with charcoal in order to obtain metal of a pure quality. On a cylinder block recently examined which had given 49,000 miles' service, the maximum wear was found to be 0.0015 in. To get such results the Cadillac Company, among many other devices, uses grinding machines for finishing the surfaces of the cores, together with about 250 jigs for core assemblies which are absolutely interchangeable, made of metal, and cost about £12 per set. Every operation is gauged just as in a machine shop. The flasks are made of cast steel and the pins and bushings are ground to a thousandth of an inch.

The American automobile metallurgists feel that not only the amount, but the condition of the total carbon is of prime importance for such work as cylinders. In fact, the question of carbon is receiving just as much attention in American foundries as silicon, although this statement is

contrary to the opinion advanced by a very eminent British foundryman, F. J. Cook, in his Paper read before the American Foundrymen's Association last spring. The same is true of phosphorus and its occurrence in cast iron. Foundry chemists in the United States are now giving earnest consideration to problems connected with the occurrence of combinations of elements in iron such as phosphides, sulphides, etc.

In the motor-car industry special metal mixtures are not uncommon. As an instance of special requirements, H. B. Swan calls attention to an exhaust manifold which was polished all over the outside surface previous to a bake enamel. Being a thin-walled casting with some comparatively heavy bosses and flanges, considerable experimenting was necessary to obtain an iron which fulfilled all requirements satisfactorily.

Where more than one mixture is used Mr. Swan points out the necessity of keeping the different classes of remelt separate so that castings of uniform analysis may be obtained. In other words, the remelt must not be recharged indiscriminately as it is in a good many foundries. If this scrap is properly handled it is possible to vary and control the silicon, manganese, phosphorus and sulphur content easily. Silicon is usually controlled by varying the amount of high silicon iron and steel scrap used; manganese by the use of ferro-manganese, and phosphorus by the amount of steel used and perhaps by the use of high phosphorus pig-iron. Sulphur in high grade American foundries is controlled to a certain extent through the manganese content, by the temperature of melting and the slag composition. The control of carbon is more difficult because the iron almost invariably takes up carbon to the saturation point, depending upon the temperature and the silicon. A high silicon mixture, that is, 2.75 to 3.00 per cent., with a fairly high sulphur, tends to reduce the total carbon, and this fact is taken into account in automobile cylinder mixtures.

The influence of moulding practice on the quality of the metal must of course be studied. For instance, in automobile cylinder work the sand in the water-jacket-cores and the large barrel-cores holds the heat so long that the surrounding metal is annealed. This is counteracted by using hollow steel or iron arbours for the barrel-cores covered with a thin layer from 3-16 to 5-16 in. of sand. A free circulation of air takes place under the bottom board, through the arbours and through the cope. This procedure will raise the hardness of the barrels from 30 to 40 points on the Brinnell scale. At the same time, a low carbon is desirable, and in most American foundries a cylinder containing from 0.50 to 0.60 per cent. combined carbon and about 2.50 to 2.70 per cent. graphitic carbon is preferable to one with the same percentage of combined carbon and over 3.00 per cent. graphitic.

Nickel in Cast-Iron.

The effect of alloys in cast-iron is, of course, being studied with the object of improving the quality of the metal, and in certain American automobile foundries pistons have been made containing 4 to 5 per cent. nickel which, when machined, give a beautiful surface, extremely fine grain and a strength of 16.5 to 17 tons per sq. in.

Tested Grey Iron.

In order to show that good results are really obtained under these conditions, the writer will cite the testimony of one more American foundryman, R. S. McPherron, metallurgist for the Allis-Challoners Manufacturing Company, Milwaukee. In discussing Mr. Cook's Paper, Mr. McPherron said that on a recent order which had passed under his observation 82 sets of tensile bars cast for a certain job averaged 14½ tons per sq. in., and on another similar order 85 sets of tensile bars averaged 15 tons. These bars represented all the tests made, and were not selected for their high value. Furthermore, they represented a medium grade of material, not the hardest iron made in the foundry, but a material suitable for machining into cylinders, liners, etc. Transverse bars of this latter mixture have gone as high as 1,280 lb. (38 cwt.). Two tensile bars cut from the bore of a liner for a 48-in. dia. gas-engine cylinder, tested by Mr. McPherron broke at 16 and 16½ tons per sq. in.; this liner weighed about 5,000 lbs. with a metal section of 1½ in. The Brinnell hardness was 183 on the finished bore. Another bar tested at the Allis-Challoner Works cut from a full-sized prolongation of a 44-in. cylinder liner showed 17 tons tensile strength. The hardness after machining was 192. This casting weighed 4,300 lb. with a metal section of nearly 1½ in.

American Malleable Iron.

In considering the character of the results obtained in American quantity-production foundries, the effect of co-operative research must not be overlooked. Perhaps the most classic example is found in the activities of the American Malleable Casting Association, with which the British metallurgical public is fully familiar. This association, which was organised largely through the efforts of John A. Penton and others, has practically transformed the American malleable castings industry from the standpoint of quality of product. The Association was organised for the specific purpose of improving the quality of American malleable iron. How well it has succeeded is fully set forth in the able Papers of Prof. Enrique Touceda presented at various times before the American Foundrymen's Association and this year before the Institution of British Foundrymen. Prof. Touceda's published data show that, starting in 1915 with metal averaging 17.75 to 20.5 tons tensile strength and an elongation of from 4 to 9 per cent., it is now not uncommon to obtain test bars of ordinary everyday metal averaging 22.25 to 24.5 tons tensile strength with 17 to 25 per cent. elongation. In a Paper read before the American Foundrymen's Association in 1920 Prof. Touceda says: "We started with low ultimate strength and elongation and made many muffs as we raised the standard, but some weeks ago we received a standard tensile test-bar, among other excellent ones, which shows over 26¾ tons ultimate strength and 33.5 per cent. elongation." This work has been accomplished by banding together the principal producers of malleable castings in the United States into an association equipped with co-operative funds for the purpose of pursuing scientific investigations into the quality of malleable iron. In addition, each member of the Association submits test bars from his daily heats, and in cases where these bars show unsatisfactory results the practice of the shop in question is immediately investigated. The result is the maintenance not only of a high standard throughout the industry, but a continuously uniformly high standard.

Steel Founders' Research Work.

Almost equally important along this same line is the work of the Electric Steel Founders' Research Group headed by Major R. A. Bull, research director. The six members concerned turned out 2,569,327 castings in 1920. These foundries use electric furnace melting exclusively. The fundamental idea underlying the work of the research group is the production of better quality steel castings, and, broadly speaking, the results are obtained through the following means: Frequent meetings of group representatives; investigations authorised at these conferences and conducted at suitable plants; general inspections of each plant by the research director; transmission regularly of reports to and from the director; and the use of the director's office as a clearing house and distribution centre for all technical information of value to the members.

The group's investigations to date have included abrasives, annealing, core practice, facing sand, gas cutting, furnace practice, the presence of slag in castings, welding and others. The interchange of information between the members has been carried to the point of permitting foremen to work in the plants of other members assisting in gathering data.

Stimulating Good Work.

To show how efficacious an organisation of this sort is in improving the quality of the product, it should be pointed out that the research director, Major Bull, makes periodic visits to each plant, preparing reports on them in turn, copies of each of which are sent to all the members. He comments upon such items as shop appearance, safety

precautions, economy in equipment operation, waste prevention, sand mixing and condition of facing, condition of moulds and cores, furnace operation, condition and handling of metal while pouring, effectiveness of annealing and welding, condition of castings when shaken out and when ready to ship, and efficiency and morale of the shop organisation. No point which has to do with the welfare of the plant or the quality of its product is omitted intentionally.

These reports of general inspections have instilled into each organisation in the association a spirit of healthy rivalry and striving after results. Like the frequent but irregular visits of bank examiners, these inspections by Major Bull furnish an incentive which keeps the working force of each shop on its metal, and in addition, of course, there is the scientific research work of the group previously mentioned.

Each plant in the group not only reports the analyses, etc., of its various heats to the director, but sends to him six sets of drillings from each heat. These drillings are sent to other plants in the group, accompanied only by secret key numbers, for analysis. In this and in other ways the analytical work is satisfactorily checked up and maintained at a high standard of perfection.

The results of the policies of the research group are evident in many small details as well as in the main phases of foundry practice. For example, except where a customer stipulates a different procedure, all castings are carefully annealed: surface imperfections, even of slight extent caused by dirt or slag, are chipped out thoroughly before being welded, and except where, because of frail design, distortion might result, all castings are put through a tumbling barrel to give them a superior finish. Certain castings from each heat are systematically cut apart and machined to ascertain interior soundness and condition.

Constant Watchfulness Necessary.

In other words, control all along the line is the answer, and the only answer, to the quality problem in a modern factory. In discussing grey iron foundry practice, Mr. H. B. Swan, of the Cadillac Motor Car Company, previously quoted, has epitomised this conception in the following words: "With a full understanding of the relations of each element and their functions, together with close melting control, it is not difficult to run an iron mixture from day to day with a small variation in composition. Of course, it is understood," Mr. Swan reminds us, "that accurate information is at hand concerning the composition of all the raw materials affecting the final product, and that frequent analysis, hardness tests, fracture examinations, pouring temperature observations, and physical tests are necessary adjuncts to close control and desirable results." In the writer's opinion these remarks sum up the philosophy underlying the manufacture of a quality product under quantity production conditions. It is all a question of systemised scientific control with plenty of brains and ability on the side of the management.

Chilean State Railway Contracts.

The Department of Overseas Trade has received, through the Commercial Counsellor at Paris (Mr. J. R. Cahill), particulars of a call for tender by the Chilean State Railways for the supply of 10,700 kilos antimony in ingots, 1,200,000 kilos pig-iron, 40,000 kilos tin ingots, 15,000 kilos lead ingots, 4,000 kilos zinc ingots, 3,000 kilos "Cintilla" (for hardening iron), 1,800,000 kilos forge coke, 1,500,000 kilos foundry coke.

Tenders are required c.i.f. Valparaiso, and should be submitted in Santiago by January 17, 1923, or at the office of the representative of the Chilean State Railways in Paris (M. Alejandro Bertrand, 88, Boulevard St. Michel) by January 13, 1923.

A copy of the circular (in French), issued by M. Bertrand and giving further particulars of the materials required, can be obtained by United Kingdom firms interested on application to the Department of Overseas Trade (Room 47).

Determination of Silicon in Pig-iron.*

Brown's Method.

A single or double factor weight, 0.4676 or 0.9351 gramme, of the sample is transferred to a glazed porcelain dish, 15 to 25 c.c. of the nitric-sulphuric acid mixture are added, gentle heat is applied to the covered dish, and the solution is evaporated to pronounced fumes of sulphuric anhydride. The dish is removed from the heat and allowed to cool. Fifty to sixty c.c. of hydrochloric acid (1:10) are added, and the contents of the dish are heated without boiling until the soluble salts dissolve. The residue of silica and graphite is collected on a 9-cm. ashless filter and washed alternately with hydrochloric acid (1:10) and hot water to the disappearance of the soluble iron, and finally with hot water until free from chlorides. The residue and paper are transferred to a weighed crucible and ignited, uncovered, at a moderate temperature until the carbon is completely oxidised, and then for a few minutes at a higher temperature to dehydrate the silica. The residual weight is multiplied by 100 and adjusted in conformity with the initial weight of the sample to find the per cent. silicon

The silica obtained by this method may be slightly contaminated, and, when an occasion demands such a precaution, its purity is determined by volatilisation with hydrofluoric acid. To do this two drops of sulphuric acid (1:1) and 3 c.c. hydrofluoric acid are added to the weighed residue. Gentle heat is applied until all fumes are evolved, when the crucible and residue are ignited at a high temperature and weighed. The loss in weight is silica. The per cent. silicon is calculated as in the preceding paragraph.

Solution Required.

Nitric-Sulphuric Acid Mixture

Nitric acid (sp. gr. 1.20)	...	750 c.c.
Sulphuric acid (1:1)	... ...	250 c.c.

Contracts Open.

Eastwood and Mearns, Renfrew, December 26.—For providing, laying and jointing about 2,500 yards of 9-in. and 1,800 yards of 7-in. dia. cast-iron water pipes, etc., for the District Committee of the First or Upper District of the County of Renfrew. W. R. Copland & Sons, 146, West Regent Street. (Fee, £1 1s., returnable.)

Southborough, Kent, December 28.—For the provision and laying of about 1,500 yards of 10-in. cast-iron water main and 6-in., 4-in., and 3-in. connections to existing branches in the main road, Southborough, for the Southborough Urban District Council. The Council Offices, Southborough. (Fee, £5 5s., returnable.)

British Empire Exhibition.

The Department of Scientific and Industrial Research has nominated, amongst others, the following gentlemen to serve on the Exhibition Committee on Science and Industry:—Sir Robert Hadfield, Mr. H. B. Weekes (chairman of the Cast Iron Research Association), and Dr. R. S. Hutton (director of the Non-Ferrous Research Association).

German Enterprise in Russia.—Dr. Serge, one of the directors of Krupps, in an interview, expressed the belief that the agreement reached between Krupps and Stomaniakoff, the commercial representative of the Soviet Government in Berlin, would be ratified by the Soviet Government. Dr. Serge declared that Krupps had been enabled to take up the concession because the participation of certain British groups had been secured to the extent of 75 per cent. of the capital in sterling value. (See our issue for December 1.) In conclusion, Dr. Serge added that Mr. Urquhart, who had taken recently a prominent part in negotiations with the Soviet Government, had promised to give his support, but neither Mr. Urquhart nor his company were providing any of the capital.

* Method used and published by the United States Steel Corporation.

Layout for Electric Tool Steel Plant.*

By Merle W. Caruthers.

The manufacture of tool steels in the electric furnace is receiving added impetus and, by the use of proper forethought in the laying out of the melting department and storage facilities, it is possible to surpass the highest efficiency previously obtained.

Of course, it is not possible to furnish any set rules that can be universally followed, but an attempt is made in the following article to present a layout that combines the good points found in a number of installations.

Steel Scrap Storage.

The question of storage for melting scrap is obviously an important one. It is the condition of the scrap, with regard to corrosion when charged into the furnace, which determines the amount of refining of the bath necessary, the quality of the steel produced and the life obtained from the furnace refractories. These factors, of course, govern the cost of the finished bar, and their control minimise factory cost.

It is a fact that the analysis of any tool steel does not definitely guarantee that the steel will be suited for the purpose intended even if the chemical composition required by the purchaser has been met. Quality starts farther back than the ladle tests or the check analyses taken from the finished bar by the purchaser. The selection and storage of the raw materials which go to make up the charge are important steps in the production of quality tool steel.

Covered sheds should be used for the storage of steel scrap. Excessively rusty steel not only fails to yield a proper percentage of its weight when melted, but forms a bath that is very high in oxides. These oxides should be reduced to insure the making of a sound steel in any case, and, when present in large quantities, the time and materials necessary to bring about proper refinement are immoderate, and consequently cause a higher priced steel without an accompanying enhancement in quality.

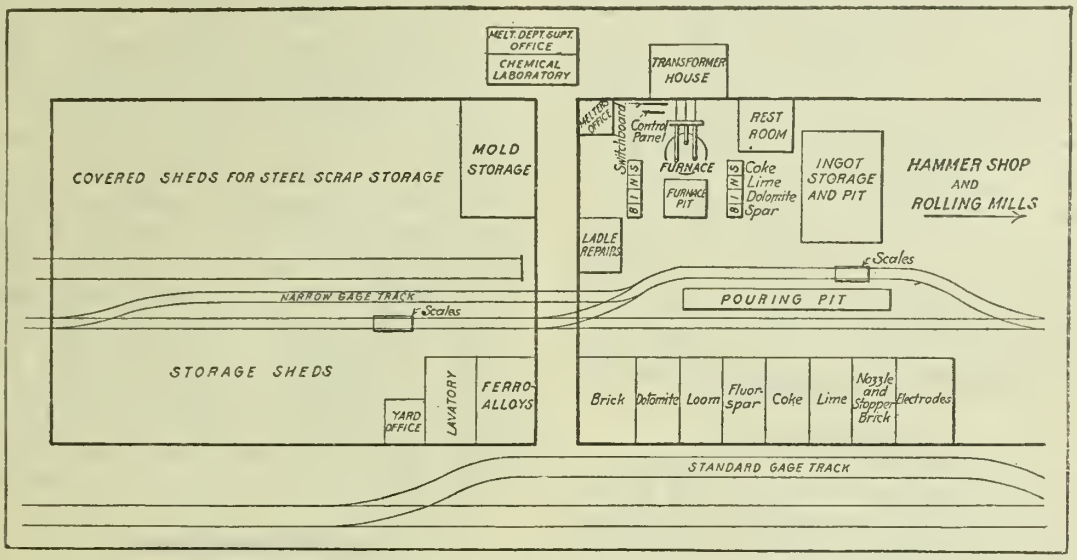
On the contrary, the quality is decreased by using a great quantity of highly oxidised scrap, for no matter what precautions are taken to "tap" under a highly reducing atmosphere, it is practically impossible to obtain a steel free from gases, and the use of rusty scrap necessarily increases the danger of getting a finished product that is not thoroughly deoxidised.

The life of the furnace refractories is shortened by an appreciable amount when the charge in the furnace consists of highly oxidised material, the increased volume of oxides making the ordinary scouring action on the lining even more severe, and hence the furnace is repaired more often. This, of course, means increased cost of repairs and consequent loss of time.

The position of standard and narrow gauge tracks, as shown in the illustration, has been selected to permit the unloading of the incoming scrap and the loading of the charge for the furnace to be performed by the same crane, and, if necessary, without even placing the scrap in storage. This last feature is sometimes advisable when it is desirable to mix heavy and light scrap for the charge without having the crane cover too much distance in doing so. It is convenient to have the track scales for weighing charges situated in the scrap shed, so that cars or bogies, when on the scales, may be served by the crane and the exact weight desired can be furnished without having to make any "shifts."

Mould Storage.

A portion of the shed which is used for steel scrap storage may also be used for the storing of new moulds and sizes not in use. In the first place, the handling of them by the crane means that any desired number can be obtained on a short notice, whereas, if it is necessary to move them by labourers using skids and bars, the time required to get out the same number as by the crane would obviously be greatly increased. Also, the moulds would be kept free from rust by being stored under a covered shed. When split moulds are used, it is good practice to coat the inside surface with pitch or some other suitable protective coatings. The coatings are burned off when the moulds are used for the first time, and the moulds have thus been preserved and the surface prevented from becoming pitted by rust.



Suggested Ideal Layout for an Electric Tool Steel Plant.

Melting Platform.

The illustration shows the arrangement of the furnace or furnaces, melter's office, bins and rest room, which make for an efficient operation of the furnace. The question of rest room should not be overlooked, as there are times when the furnace men, and particularly the pit men and ladle men, can rest for a while, and if a room is provided near their place of work it will be more attractive than to crawl off into some hiding place where they may be hard to find when needed. This, of course, applies generally to men working at night.

The installation of shower baths in the rest room affords a pleasure and comfort to the majority of men working in the melting department, and their cost would be justified by the benefits derived through better health of the employees. One of the large steel works in the Pittsburgh district installed four showers in one of their open-hearth departments, employing approximately 200 men, and they are used to capacity with a waiting line at every change of shifts. It is probably impos-

* Extracted from "The Iron Age."

sible to determine just how much good is derived from them, but it is safe to assume that better health is enjoyed by the men who use them regularly.

The melter's office should be built close to the furnace, and should be so constructed as to permit of the accommodation of as few persons as necessary. An error made in the amount of additions to be made would, no doubt, mean a "lost heat."

The storage bins for fire brick, dolomite, loam, fluorspar, coke breeze, lime, nozzle and stopper brick and electrodes should be built so that a standard gauge car could be unloaded directly into them. It is well to have them under the same roof as the furnace, so that material can be transported from them to the furnace without great difficulty and without being exposed to inclement weather.

It will also be noted that materials such as fire and silica brick, electrodes and nozzle and stopper brick, that absorb frost readily, are stored where they are protected in some degree from exposure to the elements. Electrodes and electrode joints should receive special consideration along this line, as excessive electrode breakage will result from using those which have become frozen. They should also be stored where no rain can beat in on them, as moisture is almost as injurious as frost with regard to breakage.

Furnace Pit.

The pit in front of the furnace should be so constructed that ample room is given for the receiving of a ladle larger than the rated furnace capacity. A heat is, at all times, liable to be lost in the pit, and the larger the pit the more readily can any scrap be removed from it. The walls and bottom should be reinforced with concrete, and a liberal radius should be allowed where the side intersects the bottom. This precaution is taken to add to the ease with which steel, which has entered the pit in a liquid state, can be removed after solidification. For this same reason it is good practice to cover the bottom of the pit with a layer of loam about 2 in. thick.

It is desirable, when possible, to have the melting platform, furnace with control panels, bins, etc., elevated about 10 ft. above the pouring platform, but the expense of such an arrangement is sometimes considered inadvisable. In case the melting and pouring platforms are on two separate levels, it is obviously unnecessary to have a pit, as the ladle for receiving the heat can rest upon its trunnions, supported by standards placed on both sides of the ladle for this purpose.

Ferro-Alloy Storage.

The cost of ferro-alloys and the ease with which some of them can be mistaken for each other makes it expedient that they be kept in bins in a general storage room made especially for them. This will also have a psychological effect upon men held responsible for getting the alloys to the furnace, as the more orderly the condition of the storage house the more care will be taken in keeping them in separate piles about the furnace.

The writer recently visited a steel works using ferro-manganese and ferro-chromium, and noticed a pile containing approximately 1½ tons of what looked at a distance to be either ferro-manganese or ferro-chromium. Upon making inquiry, it developed that an inexperienced labourer had mixed 1,100 lbs. of ferro-manganese with a pile of ferro-chromium, and the resultant mixture was of no use because of the fact that no heats were made at that plant using those amounts of manganese and chromium in combination.

This is an example of carelessness that is not uncommon around a steel works, and, although the amounts involved in this case are larger than are required in an electric furnace tool steel works, it still remains a fact that setting the right example for some workmen in maintaining orderly looking storage houses has a decidedly lasting and desired effect upon the men taking materials from them.

The making of quality steels by the electric furnace process necessitates the running of preliminary analysis on such elements as carbon, manganese, chromium, etc., and the holding of the heat in the furnace until the results of the laboratory have been received. When the laboratory is near to the furnace, much time can be saved.

Ingot Storage.

Ingot storage facilities should be arranged so that it is possible to bury ingots hot in a pit if desired or to store them cold in piles. Heat numbers should be stamped or marked legibly on each ingot, and the ingots should be piled in such a way as to have their identity outward and easily obtained.

General Remarks.

Tests which are being made from day to day to determine the physical properties of different grades of tool steels show that one company's steel may be of higher quality than another's, although they have, in all probability, bought their alloys according to the same specification, used the same grade of scrap, melted to the same chemical composition, and cogged their ingots at the same rate of reduction and at the same temperature. The difference is due to the fact that the first company has learned that quality must be injected at every stage of manufacture, while the second company, overlooking this fact, has only met the chemical requirements.

We are slowly realising that hit-or-miss methods have no place in present-day steel manufacture, and also that the physical requirements of any tool steel are far more important than the chemical composition. It remains for some standard testing apparatus to be designed that will reveal the true requirements of tool steel, and, until that time comes, the greatest safeguard against poor quality is by using steels that have been made by up-to-date manufacturers using up-to-date methods and equipments, and controlled by up-to-date supervision and design.

[The layout exemplified by Mr. Caruthers presents many excellent features, but we would suggest that the system of filling and emptying the scrap storage sheds is liable to result in the constant use of new material and the leaving of the old at the back of the shed to rust away over indefinite periods. To our mind the sheds should be filled from openings in the outside wall, the system apparently adopted for all other materials. Additionally, we suggest that a broad gauge track running past the chemical laboratory and the transformer house would allow of the rapid despatch of transformers to the manufacturers should they burn out. The superintendent's office and laboratory we would fit into the corner made by the melter's office and transformer house, pro viding a hatch between the laboratory and melter's office sufficiently large for the passage of samples. This would save much time. A further suggestion is that room should have been allowed for the incorporation of a second melting unit should the business of the concern increase sufficiently to warrant it.—Ed.]

Swedish Iron and Steel Production.

The Commercial Secretary at Stockholm (Mr. H. Kershaw) has informed the Department of Overseas Trade that, according to the quarterly report of the Swedish Ironworks Association, the output of pig-iron and steel was perceptibly increased during the third quarter of 1922, in comparison with the same quarter last year. For the first three quarters of the year the output of pig-iron was 184,000 tons, as against 257,600 tons during the same period last year (the decrease was caused by the restricted production of the blast furnaces during the first quarters of the year), of steel ingot 226,800 tons, as against 100,400 tons during January-September last year, and of rolled iron 153,300 tons as compared with 83,100 tons last year. The total exports of iron and steel during the three quarters were 125,000 tons (of which quantity 33,700 tons were pig-iron), as against 101,200 tons during the same time last year, whereof 58,800 tons were pig-iron. The imports show diminished figures, amounting to a total of 90,700 tons as against 107,000 tons during the same period of 1921. The number of blast furnaces in operation at the end of October represented about 25 per cent. of the total number capable of working, whereas the puddling and steel furnaces in operation were 33 per cent. and 39 per cent. of the total number.

Gating, Feeding and Casting.

By E. Longden, A.M.I.Brit.F.

(*Continued from page 490.*)

EXAMPLES OF FAULTY AND SUCCESSFUL GATING AND FEEDING METHODS.

It is sometimes amazing the trouble in which the foundryman is involved to secure a good casting of apparently simple design.

The bottom sketch in Fig. 1 shows the section of a casting which might represent a Ramsbottom ring, a valve seating, or any casting of similar form which is machined all over and is required without blemish. The middle sketch shows the usual way of gating the casting. When run in that way wasters frequently occur, due to gas-holes on the top side, mainly on opposite side to

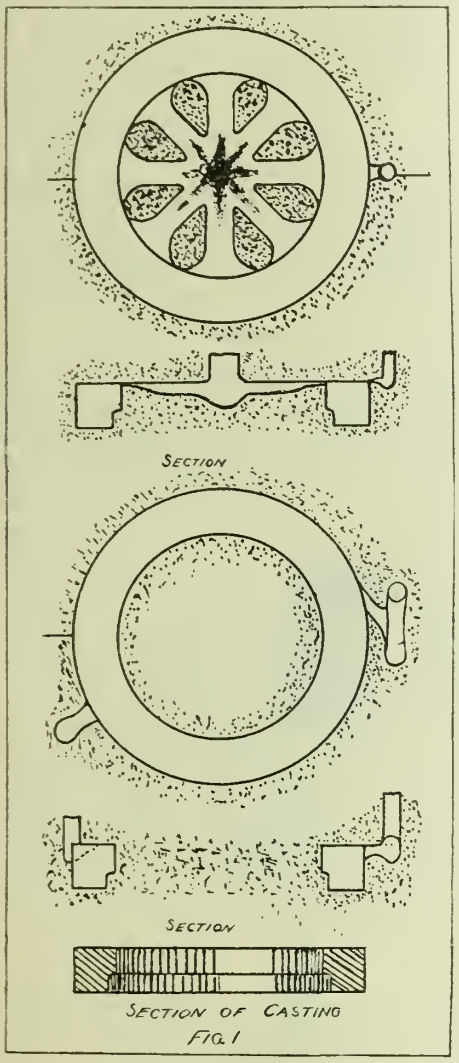


FIG. 1

runner; also dirty spongy places appear occasionally near runner entrance. Wasters are rarely encountered when employing the method of gating depicted in the upper sketch. It will be seen that an almost continuous ring of spray runners is employed, allowing the metal to be admitted to the mould at a uniform temperature throughout. With such a casting and the two examples following, very good results were obtained on adopting the method outlined.

Gas Engine Valve Head.

Fig. 2 shows sketches of a gas engine valve head quite a simple looking casting. They are required absolutely sound, especially on the seating A. Defects frequently occurred in the places shown in the top drawing, which is the machined shape. The defects were due to gas and shrinkage cavities, which cropped up persistently with the various methods of gating until the plan outlined in the bottom sketches was evolved. Again, a series of sprays was adopted completely encircling the casting. A tapered iron chill core was substituted for the centre sand core. Excellent results accrued.

The successful application of this method tempted the author to try it on a larger and still more troublesome casting—the gas engine valve shown in Fig. 3. It is one of the most difficult castings to produce. A speck, particularly on the seating B, is sufficient justification for rejection. It was quite usual to make three or even four castings to obtain a good one. Previously the usual methods of gating were, as in the case of the valve head, by horn- or cut-gate, as shown in the top right-hand sketch. No really satisfactory results were obtained until employing a ring of runners, as shown in the bottom sketches. The only difference in running between the valve and the two previously mentioned cases lay in the

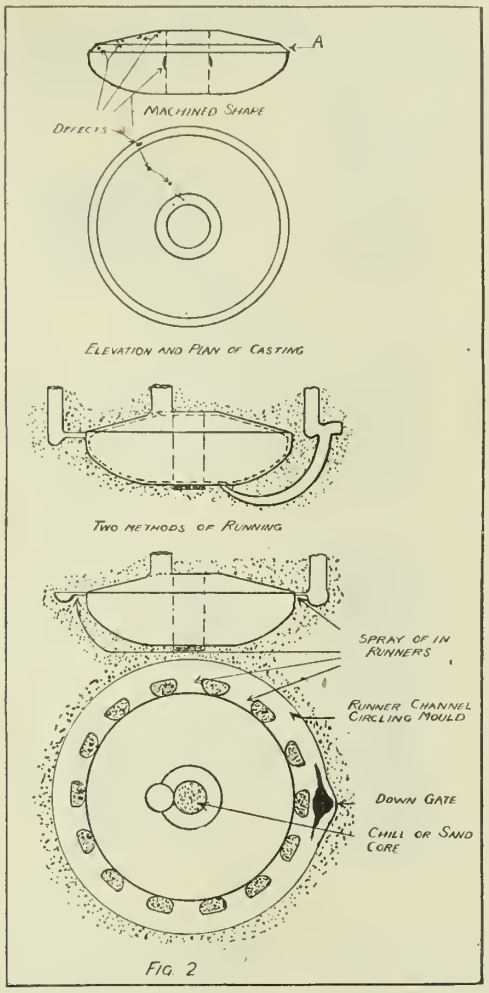


FIG. 2

addition of a second ring of runners a little higher up in the mould.

An explanation of the reason for the success accruing from the adoption of this process of running will suffice for the three castings which have now been mentioned. Again referring to the top right-hand sketch, depicting the old method of gating and visualising, the progress of the entering metal, it will be seen that, if run by one simple in-gate similar to the one marked D, the metal first falls to the bottom side of the head. As the metal rises towards the neck on the other side from the runner gases tend to accumulate there, and are not removed by new clean metal. A hot spot is also formed near the in-runner, and shrink holes appear with the usual attached gas globules. When run by a horn gate, as shown at E, no hot-spot troubles seem to appear, but there is still the occluded gases arranging themselves on the top of the head, as indicated by the arrow at F. The second ring of runners was applied with a view to avoiding the passage of too much metal through the head.

Worm Castings.

Fig. 4 shows a half-sectional elevation of a worm casting and mould. Gated on the side in a variety of ways only produce shrink-holes at the base of the worming. By gating and feeding as indicated in the sketch the trouble disappeared. Here is an instance of a casting being fed through a thin-sectioned runner when constructed in the manner shown. These worm castings were made soundly in both cast iron and steel when gated as described.

Cylindrical Castings.

To run a pipe-shaped casting in a similar way to that shown in the left half-sketch, Fig. 5, very often results in sponginess about the runner. Apart from a hot-spot being formed, it appears, on examining the metal about such a runner entrance, that an extraordinary amount of graphite is present. The graphite would appear to be very much oxidised, too; this is more apparent if metal has been poured "sluggish." It is suggested that the best and easiest way to run is by top-gating, as shown in the right half sketch.

Liner Castings.

Fig. 6 shows a tangent gate adapted to run a short liner about 18 in. deep. It will be noted

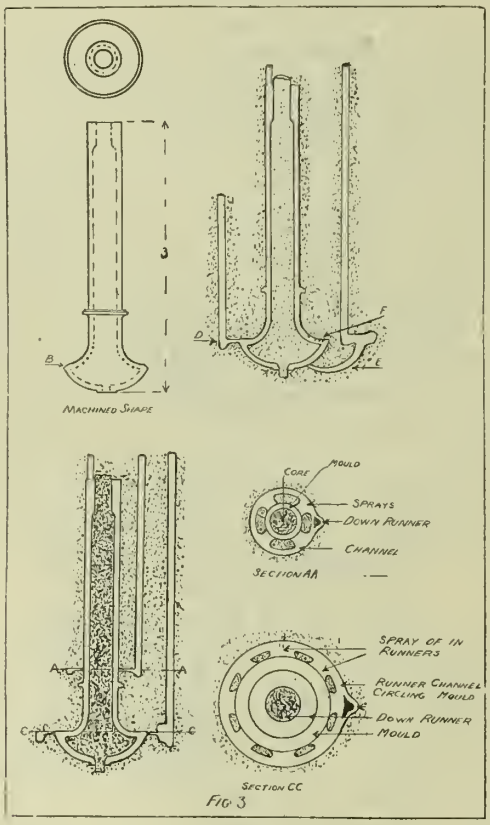


Fig. 3

that the in-gate enters the mould just a little higher than half way. The swirl is then exerted more strongly towards the top, where it is most needed. The in-gate should be formed in a core and tapered as shown. With liners having greater depth, the author strongly favours top pouring. Liners as heavy as 3½ tons are cast very successfully by pouring a small amount by way of a bottom runner to form a cushion to receive the bulk of metal from a series of top gates.

Condenser Bodies.

Fig. 7 gives a sketch of the top end of a condenser body. Some years ago the author was surprised to see such a condenser, about 7 ft. dia. and 12 ft. deep, and with a flange, cast without a reasonable amount of head to receive the scum and feed. Only 1 in. of machining was allowed on the top flange, with the result as one would expect. Cavities were disclosed after machining, as indicated in the upper drawing. An 8-in. head was the means of securing a sound casting.

Another interesting incident is recalled by the sketch, Fig. 8. It gives dimensions of a 40-ton plate, cast for the purpose of moulding a turbine housing. The morning after pouring the plate was seen to be cracked completely from side to side. If the directional flow of the metal is followed, as indicated by the arrows, one might suggest that where the streams meet and converge in the centre, a hot line and agitation is set up which resulted in a concentration and excessive growth of graphite, tending for a time, whilst cooling from the solid, to push towards the length of the plate, at the same time contraction would be taking place more rapidly towards the corners. This is one of the reasons why plate-like castings

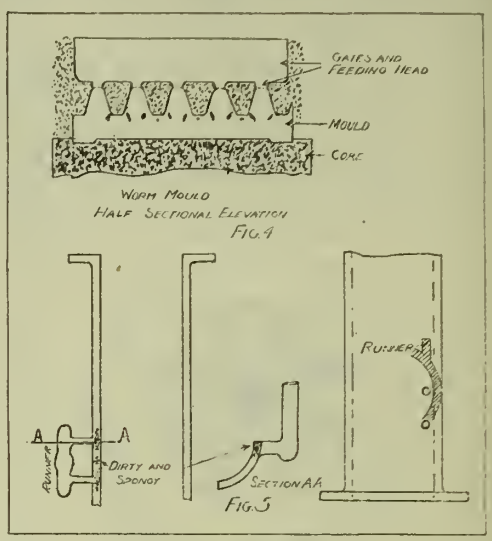


Fig. 4 Fig. 5

warp, particularly if gated on the top of the plate.

Cylinder Covers.

At Fig. 9 sketches of a cylinder cover and methods of gating are shown. The top drawing gives the plan and sectional elevation of the casting. Below is seen a faulty way of making them. In this case the flange side is cast down.

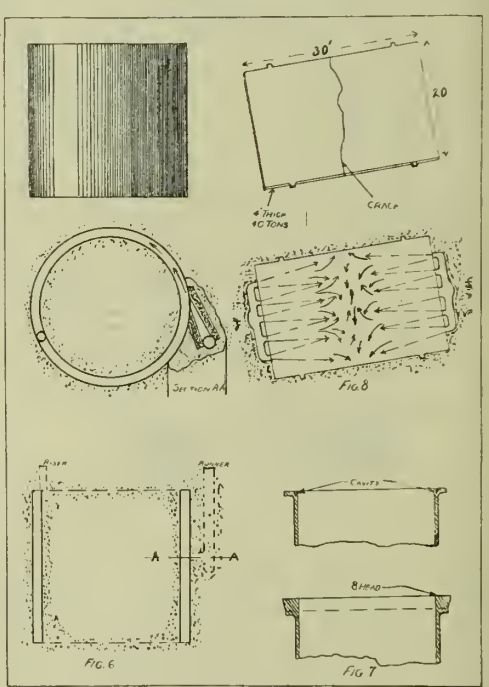


Fig. 6 Fig. 8 Fig. 7

Two inches of head metal were allowed on the top side as cast. They were made in this way for many years. About 5 per cent. waste was recorded, due to sponginess at the places A. Wasters were reduced to approximately 1 per cent. when cast in the manner described in the bottom sketch; flange-up, with only the usual machining allowance of ¼ in., horn-gated, poured slowly, and fed through a riser placed over the central boss of metal.

Diesel Cylinder Heads.

Fig. 10 shows a part of the sectional elevation of a Diesel cylinder head. An attempt was made to eradicate sponginess appearing at the points A by employing a heavy tapered riser, as shown in the top sketch. Several hopeless wasters resulted.

The large riser was surrounded with hard strong sand, practically a core sand, and almost touching the bars of the moulding box. It will be apparent that the casting would contract first, leaving the heavy riser suspended between the box bars. A piece of the casting just above the hottest spot under the riser followed, and became suspended along with the feeding head, resulting in a contraction crack as indicated at the place B. An alteration in the bars of the box and with a riser formed similar to the one in the lower sketch, and an application of chills about the porous place mentioned, gave good castings.

Filleting Riser Gates.

Fig. 11 illustrates the right and wrong way to form a button on a riser gate. The sketch on the

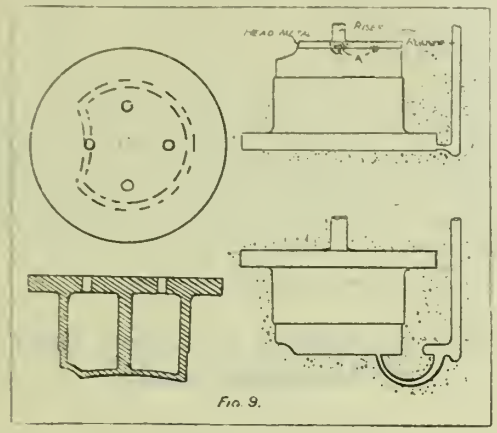


Fig. 9.

right is the wrong way, that on the left the correct way. As is well known, the metal crystals, on cooling, arrange themselves at right angles to the cooling surface. It explains why a riser with a rounded fillet breaks into the casting.

Jacketed Cylinders.

Fig. 12 shows the top side of a jacketed cylinder with wrongly-positioned drop runners.

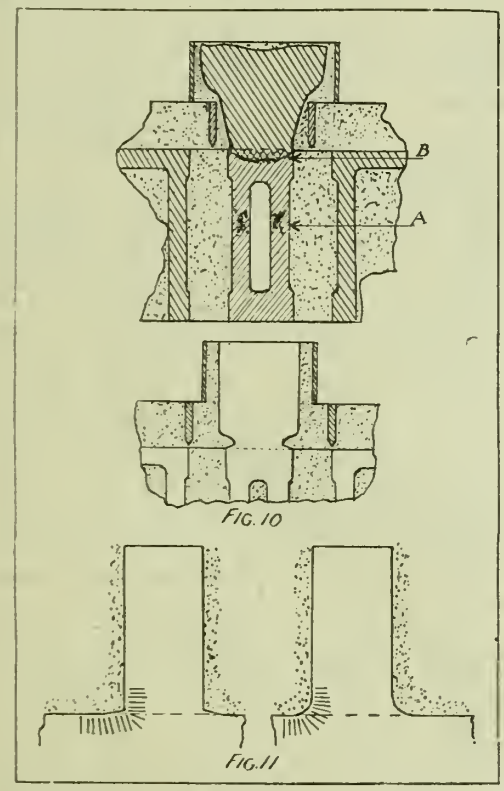


Fig. 10

Fig. 11

An examination of the side view will reveal that instead of the metal falling clear through the mould, the runners direct the flow so that it impinges on the shoulder of the jacket-core scouring it, until a piece of the core between the runners becomes detached.

The next sketch, Fig. 13, shows a part-section of a cylindrical casting. If the mould is deep, and when using top-gates alone, one sometimes obtains a scoured place at the bottom of the mould directly beneath one or more of the runners, in spite of sprigging. The right-hand sketch shows the application of top and bottom pouring, which remedies the evil.

Steam Cylinder.

A steam cylinder is shown in Fig. 14. The manner in which the cylinder is gated will illustrate a clean and successful method of running which, with modifications, can be applied in the gating of various special castings. In most districts such cylinders are cast vertically and gated round the bore with a series of drop runners, as shown in the plan sketch at C. That way is preferable. This sketch is specially shown to illustrate how cylinders up to 3 tons can be, and have been, produced without defects when casting the bore horizontally. Hundreds were made with not more than 2 per cent. waste. The section on line A, A gives a sectional elevation of the mould with gates and runner basin. It will be noted that the metal enters through the flange on the valve side by two in-gates, D. These gates should

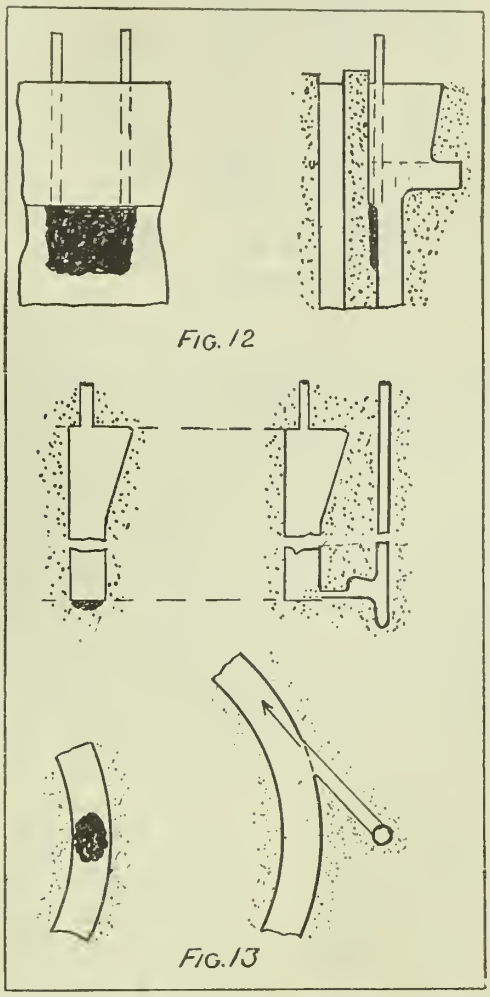


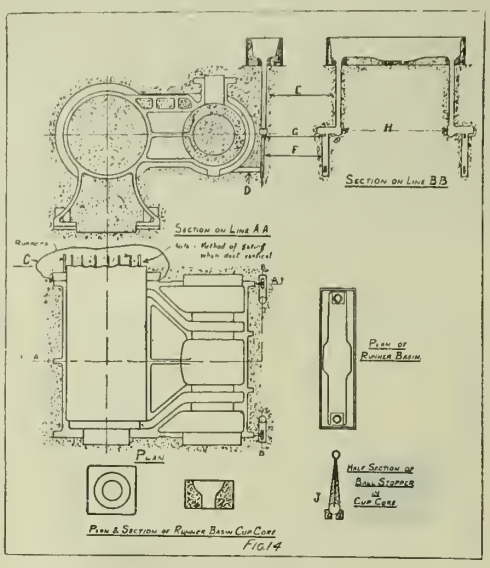
Fig. 12

Fig. 13

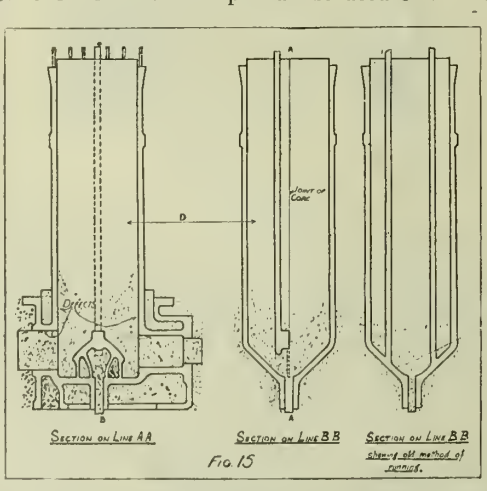
be formed in a dry-sand core. The plan shows how the gate channels on the joint of the mould are shaped. Section B, B, gives a side view of the down-gates and runner basin. The main down-runners, E, leading from the pouring basin are much larger than the lower down-runners, F, which feed the in-gates, D. A piece of core, G, is placed across the top of the lower down-runners, arresting the flow of the metal and allowing scum to be trapped in the skim-chambers, H. The pouring basin is deep, and not too wide. In the centre, where the metal is first poured, a piece of loam cake is bedded. The mouth of the down-gate, I, is formed in a cup-shaped core. A plan and section of the cup core is seen at the bottom of the illustrations. The mouth is neat, and so formed that the ball-stopper, J, can rest in it accurately without breaking any proud sand and effectively excluding the metal until the runner-basin is full, when the stoppers are lifted.

Fig. 15 shows the outline of what might represent a gas or oil engine cylinder. Some hundreds of passable cylinders had been made gated through

the core, as shown in the right-hand sketch. Gated in that way, the metal strikes violently the core forming the combustion chamber and rushes in the direction of the admission and exhaust branches, where gas and shrink holes were occasionally found. In most cases the defects were disclosed about the places indicated by the arrows. Most excellent castings were produced when they were gated, as shown in the right and the middle sketches. Instead of two runners pounding directly on the combustion chamber core, a combination of top and bottom pouring was arranged.


Section on Line A A
Section on Line B B
Plan of Runner Basin
Plan
Half Section of Basin Stoppers in Cup Core
Plan & Section of Runner Basin Cup Core
Fig. 14

The core, D, forming the bore and branches, is made in halves, and fastened together after drying. One of the down-runners is rammed up in a half-core below the joint, as in the old method, but with the difference that it does not continue right through the core. As will be seen, it stops short of coming through the core by about 6 in. The blow of the first metal is thus delivered on the inside of the core. Here a skim-chamber is cut to the joint of the core, from which four thin sprays are led gently to the combustion chamber. When sufficient metal has been admitted by the bottom runner the mould is filled by a number of top drop-gates arranged round the bore. Excellent castings are thus produced. When run in the former way the metal which rose up the bore was not the best metal, due to it being a little sluggish towards the top, where it ought to have been the hottest. A porous structure was the



result. Also when gated altogether from the bottom chills, which were placed about brackets between the jacket and outside of bore, soon lost their chilling effect, because much of the metal to fill the bore would wash past them.

It may be interesting to give a few examples of pouring speeds. In the following table the times given are from when stoppers or plugs are lifted.

In a Paper read by E. E. Burgess before the Association of Engineering and Shipbuilding Draftsmen entitled "Notes on Marine Diesel Engine Castings," he stated that an Italian firm, Geo. Ansaldo, have been very successful in the production of Diesel engine cylinders. In casting the large cylinders in one piece, it is usual to endeavour so to arrange the mould that the casting stresses set up will be acting in opposition to the temperature stresses when the engine is working, in order that the two may tend to neutralise each other. This is altogether a matter for long

Table I.—*Showing Teeming Speeds for Various Castings.*

Type of casting.	Weight in cwts.	Pouring speed in cwts. per min.
Bedplate—		
35′ × 8′ × 5′ × 1¼″	440	146
Bedplate	140	70
Flywheel	300	200
Steam and gas engine cylinders	50	25
Ditto. ..	20	20
Cylinder pistons ..	7	7½
Cylinder piston covers	7½	10

experience in the making of such cylinders. Great precautions are taken in pouring them, castings weighing 10 tons being poured in as short a time as 30 secs. An analysis of the iron used for these cylinders is given as:—Carbon combined and graphitic, 3.81; silicon, 1.36; manganese, 0.57; phosphorus, 0.3; and sulphur, 0.28 per cent.

The Treatment of Green Sand Moulding Sand.

By M. J. Cooper.

In addition to, and apart from its chemical and mineral composition, moulding sand when prepared and in its green state, contains a large proportion of air, and this air has a most important place in governing the functions of the sand when in actual contact with the molten metal. Ordinary green sand when damped and mixed to the proper temper for use, and when passed through a sieve of ⅛ in. mesh probably contains 50 per cent. of air. The action of ramming displaces the air in proportion to the intensity of ramming. It decides the density and the conductivity and plasticity. Therefore, however carefully the facing-sand may have been selected and prepared, and though its chemical and other properties may be ideal, careless treatment during ramming will nullify all the initial care spent in its selection and preparation.

The rammer should never approach within 1½ in. of the pattern, and then only when using very coarse sand; and after pressing the facing-sand firmly up to the pattern, it should always be carefully borne in mind that the rammed portion of the sand acts only as a retaining wall for the facing-sand, through which ultimately the steam and gas generated will have to escape.

The more the sand is compressed, the more this free air is driven out in the ramming process, the less ventilating properties it retains and when in contact with molten metal, pockets of steam and gas are formed immediately behind the face of the mould, creating pressure zones which, seeking release, flake off the face of the mould and leave the familiar scab. Failing a complete breakway, small jets of gas force their way through the face of the mould and into the metal whilst in its molten state, and create the small gas holes found when the machine tools break through the skin of the casting. These are often attributed to sulphur and other supposed impurities in the metal, whereas careless ramming is usually to blame.

Again, when the sand is rammed too hard the coal dust which has been mixed with the facing-sand, instead of fulfilling its proper function, becomes an element of trouble by creating gas, which, failing to escape through the retaining wall of sand, has to make its way through the body of the molten metal, and eventually as the metal sets, it becomes trapped.

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An Apprenticeship Course in Foundry Practice.—XXIII.

By Ben Shaw and James Edgar.

DRY SAND MOULDING.

The term dry-sand moulding does not mean that dry sand is used, but sand which, when given the requisite shape, is capable of being dried. Dry sand would be entirely useless in the formation of a mould, but the expression is used to distinguish it from sand used in green-sand moulding, and to determine the class of mould to be prepared for a given job. The sand, when used for a mould to be dried, contains moisture to an amount comparable with a green-sand mixture, and frequently contains more moisture to increase the ease by which it can be worked. In green-sand moulding the moisture content of the sand used must be kept as low as possible consistent with the maintenance of the shape given to it, because of the difficulties experienced in obtaining the ready escape of steam and gases generated when casting, and also because additional moisture occupies space which reduces the permeability of the mould. In a dry-sand mould the moisture is evaporated from it, therefore the mixture of sand used can carry additional moisture to make it more plastic or workable, because the resultant mould is not adversely effected, excepting that additional time may be involved in drying it previously to receiving the metal.

The production of castings in dry-sand moulds is a very important part of the foundry industry, and dry-sand moulders occupy a prominent position in the organisation of the average foundry. Dry-sand moulds are prepared to receive steel, iron and the non-ferrous metals, but more particularly are they invalnable for producing castings in steel and iron. This does not mean that it is necessarily safer to cast non-ferrous metals into green-sand moulds than, say, cast iron, but castings composed of these metals and alloys are, as a rule, smaller—there being comparatively few large castings which necessitate the use of dry-sand moulds—less labour is involved in the formation of these moulds, and there is less risk attached to the production of sound castings because of the work being small.

Generally speaking, the majority of medium-sized and large castings are made in dry-sand moulds, although it must be borne in mind that in some instances comparatively small castings are made in dry-sand, whilst on the other hand castings weighing many tons may be, and are, satisfactorily cast in green-sand moulds. These are, however, exceptions to the general rule, the character and quality of the metal and the simplicity or otherwise of the required casting, influencing the choice of either green- or dry-sand moulds, besides cheapness and quality of the resultant castings. The fact that a mould is dried before it receives the molten metal necessarily increases the cost of such a mould, and this naturally influences the cost of the casting; it is therefore necessary to inquire into the relative value of dry-sand moulding compared with green-sand moulding, and endeavour to show what compensation is obtained by casting the metal into a dried mould.

Advantages of Dry-Sand Moulds.

Castings produced in dry-sand moulds have a comparatively clean skin, blow-holes are not so prevalent, and the structure of the metal is more regular than with castings that are made with green-sand. Thus dry-sand castings are generally sounder and cleaner, and they can be relied upon to a greater extent than those made in green-sand. While this is an important consideration, there would be practically the same need for dry-sand moulds, even though the resultant castings were of equal soundness to green-sand castings. Generally, the moulds for medium-sized and large castings take considerable time and labour to prepare, and the sand gives off much of its moisture in the process, particularly the surfaces against the pattern when an unvarnished or unpainted pattern is used. A green-sand mould depends largely upon the moisture content for its bond, and therefore the surface of such a mould, especially corners of sand, are very fragile. It is admitted, of course, that the mould can be swabbed to restore its strength, but the too frequent use of the swab on the green-sand moulds is generally disastrous to the casting. On the other hand, a dry-sand mould can be swabbed without fear, and since it is a stronger sand, the mould surfaces can be sleeked with greater ease. Then it must be remembered that many moulds for large castings occupy one or two days to core-up and cover preparatory to casting.

With green-sand moulds, unless an oil-bonded core-sand is used, there is the danger of the cores absorbing moisture to such an extent as to make the casting of metal into the mould a very risky undertaking. There is not this danger with dry-sand moulds, and they offer better support for cores, because they are stronger. The amount of metal to be cast into a mould, the speed at which it is poured, and the influence of the molten metal upon the mould, must be considered when determining the relative values of green- and dry-sand moulds. When the cover of a mould is largely exposed to the direct heat of the metal during the time of filling, there is a probability of drawing the cope or causing part of the sand forming the cover to fall on the metal.

A dry-sand mould is not subject to this weakness to anything like the same extent as a green-sand mould. Green-sand is more liable to show signs of the effect of the wash of metal near the runners, and green-sand cannot be rammed sufficiently hard with safety to resist the pressure exerted by the fluid metal in a deep mould. Castings so made are more or less misshapen about the side near to the bottom, due to the presence of swellings caused by the pressure of metal. The surface of a green-sand mould cannot be protected from the influence of the metal so readily as dry-sand moulds, and consequently castings in steel, and sometimes in iron, show sand burnt on them. Many moulds made in dry-sand would be made in green-sand, but greater care would be necessary in the formation, and however much skill was employed, they would be comparatively delicate and more likely to result in waster castings than by using dry-sand moulds. No hard and fast rule can be drawn between work which should be cast in green-sand or dry-sand moulds. In some foundries castings are made in green-sand that would be made in dried moulds in others. It is largely a matter for individual experience, the foreman moulder frequently giving preference to that class in which he has specialised, at the bench or on the floor, as a journeyman. On the other hand, he may be guided by the manner in which previous work has been done in the foundry for which he is responsible.

Sand for Dry-Sand Moulding.

Sand to be dried requires a greater amount of bonded strength than green-sand mixtures, in order to make up for the absence of moisture when dried. Thus, whatever kind of metal is to be cast, the sand for moulds to be dried is stronger than would be used for similar metal in green-sand. For steel castings "Yorkshire," Cornish and Belgian sands are used because of their relative freedom from impurities, a very important consideration for the high casting temperature of such metal. The mixture used for facing varies with the bonded quality of the sand and to suit the class of work to be done. The fineness of the sand, too, is a variable quality, and usually the larger the work the coarser the grain, in order that the mould will be more permeable. For large steel castings, particularly those that are other than mild, composite is more frequently employed, it being less liable to burn on the surface of castings than the previous sands referred to.

The sands for moulds for cast iron are more plentiful, though few can be used without any admixture. Erith sand is one of the exceptions, particularly the darker variety. When old loam is available from work which has been cast in loam it is advantageously employed, together with new sand, in making a facing mixture for dry-sand moulds. With many sands that are weak in bond clay may be added to give the requisite strength; on the other hand, a strong mixture may be weakened by adding blacking, sharp sand or coke. Dry-sand mixtures are preferably milled to toughen them. No coal-dust is added to dry-sand facings for iron castings such as is used in green-sand mixtures. Somewhat similar mixtures are used for the facing sands employed in the making of dry-sand moulds to receive the bronzes and brasses, although the texture is, as a rule, finer. With regard to dry-sand moulds for aluminium, when they are employed, owing to the reduced pressure of the alloy on the mould and the fact that its contraction is considerable, it is better to use a weaker mixture than would be used for other non-ferrous alloys.

Surface Wash on Dry-Sand Moulds.

One great advantage the dry-sand mould possesses over a green-sand mould is the superior skin produced on the casting. This is largely due to the refractory facing applied in the form of a wash. The material used to form the wash varies according to the metal to be cast; thus for mild steel castings the dry-sand moulds are coated with a wash consisting of graphite and flour-silica, to which a good-quality clay, such as china clay, is added, and sufficient water to give it the consistency of cream. For hard steel casting steel-moulder's "compo." is frequently thinned with water and used for the purpose, although graphite is often added.

Mineral blacking is generally the main constituent of the wash given to dry-sand moulds for cast iron, but graphite improves the quality and increases the ease with which it can be sleeked. Clay is frequently used as a bond for this wash also, whilst some prefer a carbonaceous bond such as core-gum, claiming as they do that the sand leaves the casting better, but a clay-bonded black-wash, when carefully prepared and applied, causes the sand to "peel" readily from castings. The blacking, or the blacking and graphite, according to the quality of wash required, is added to water in which sufficient common clay has been mixed to make it well coloured. For large work little, if any, graphite is added as a rule, but for small or medium-sized work of an intricate character and on which a smooth, clean skin is desirable, graphite as an addition to the blacking increases the quality of the wash.

For dry-sand moulds to receive bronzes or brasses graphite is frequently used, especially with the former, but a combination of graphite and French chalk, or French chalk alone, gives a very good surface. Flour or peas-meal is often preferred as a bond for this wash, though clay is sometimes used for the purpose. A similar wash may be used for aluminium, although graphite may be profitably excluded.

The quantity of bond required for these surface-washes is best determined by experimental tests. Too much is as bad as too little, for then the surface to which it is applied cracks on being dried and the wash tends to peel off, whereas when the bond is relatively low it is easily brushed off after being dried. The opinions of dry-sand moulders vary considerably on what constitutes a good wash, but the skin on the casting is the best guide. When the castings show scales it usually reflects upon the quality of the wash applied to its mould, although the method of application may result in the disfigurement of the casting.

Applying the Wash.

Sometimes dry-sand moulds are painted or washed while they are green in order to save time in drying. When this is done a swab should be employed to apply the wash, and care must be exercised in sleeking, a practice which is not so frequently done as formerly, otherwise the thin protective layer of fine refractory material will be removed in places. Usually the moulds are dried before the wash is applied, and a better opportunity is afforded for preparing the mould to receive the wash. It should be applied while it is hot; not too hot, however, but sufficiently so to allow the work to be handled with ease. A brush should be used for painting a dried mould, and the brush marks should be sleeked out to obtain a smooth surface. In many foundries little sleeking is done, the irregularities, due to quick drying, being reduced by using water. The too frequent or careless use of the water-brush removes practically all the protective coating, and reduces the quality of the skin on the resultant casting. Owing to the presence and method of applying washes, castings are not so well defined in dry-sand moulds as in those of green-sand.

Birmingham Metallurgical Society,

Some Aspects of the Mechanical Treatment of Metals.

In a recent lecture delivered before the Birmingham Metallurgical Society, Dr. F. Johnson (Head of the Metallurgy Dept., Municipal Technical School, Birmingham) drew attention to the fact that metals and alloys are very frequently used in the worked condition. The influence of mechanical treatment differs largely with the temperature at which it is carried out, and it is necessary to distinguish between hot-working and cold-working. For many reasons it is desirable to retain metals in service in the cold-worked condition, e.g., overhead telegraph wires, for only in this way can there be an appreciable economy of metal.

By cold-working the strength, elasticity, stiffness and durability of ductile material are greatly increased, and all the physical properties are affected.

The lecturer dealt with the inner structure of the crystal-grain, the modern conception of the arrangement of atoms in the space-lattice of each grain, and the relationship between types of this arrangement and the working properties of metals. This modern conception is due entirely to recent application of the X-rays to the study of metallic structures, thus reinforcing the knowledge previously obtained from the use of the microscope.

Considerable stress was laid upon the recently advanced "slip-interference" theory of the hardening of metal, either by alloying, cold-working or heat-treatment. According to this idea, "slip" along the planes of weakness in the crystal-grains of ductile metal is hindered by refining the grain, i.e., causing a large number of small grains to occupy the space of a few large grains or by introducing a component which forms a harder constituent than the ductile metal to which it is added and in which it is scattered as isolated grains. The finer these grains, the greater the interference with slip, and therefore the greater strength and hardness. This strengthening effect is of an external character and is in the nature of a reinforcement of soft grains by harder neighbours. "Slip-interference," however, can go further than this, for by careful heat treatment alloys such as duralumin and steel can have their hardness and strength increased enormously as the result of bringing about the uniform distribution of a hard constituent in very fine particles within the soft grains, thus clogging the movement along slip-planes when external force is applied.

The lecturer concluded by reference to recent investigations carried out on the influence of cold-working on metals and alloys in his own department and elsewhere.

American Malleable Castings Association.

Mr. Robert E. Belt, the secretary of the above Association, has arranged for its members to participate in the American Foundrymen's Association's Annual Convention, to be held in Cleveland next May. This is a lead which might be usefully followed by the Institution of British Foundrymen.

American Methods of Sampling Pig-Iron.*

INTRODUCTORY REMARKS.

Rapid determination of the constituent elements of pig-iron, with the exception of sulphur by the volumetric method, is susceptible of a very satisfactory degree of accuracy. With respect to sulphur, the volumetric method is the only one, up to the present, by which the determination can be made within the time limits fixed upon the iron laboratory. The degree of accuracy attainable in a volumetric determination of sulphur, however, is largely dependent upon the grade of the iron and the condition under which the test is taken. A method of sampling molten iron which produces a highly chilled test, such as the water shot method, is not desirable, because such a condition in a test piece is conducive to low results when sulphur is determined thereon by the volumetric method. This is due to the fact that, upon dissolution of chilled iron in hydrochloric acid, volatile organic sulphur compounds are formed, which are lost in the process of volumetric determination on account of the inability of the absorbent solutions employed to retain them. The use of such chilled tests makes it necessary to anneal the sample previous to making the determination for sulphur, an operation that lengthens the time of and complicates the determination, and is therefore to be avoided.

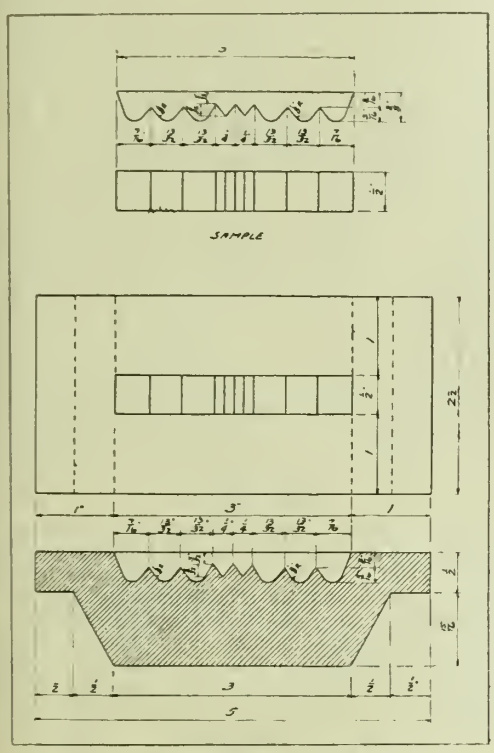


Fig. 1.—Test Piece and Mould for Sampling Molten Pig-iron for Chemical Analysis.

Inasmuch as the condition of chill is the predominant influence which causes the formation of non-absorbable gases, it is evident that a successful method for sampling molten iron should yield a test piece which is free from this objectionable condition. The method of casting in sand meets these requirements, and it has been found, moreover, that a sand-cast sample gives an accurate measure of the sulphur content by the volumetric method. However, owing to the danger of contamination from the sand, this sand test is not suitable for the determination of silicon, nor has any method, practical for routine work, been devised for combining sand tests from different parts of a cast into one representative analytical sample.

The methods for sampling which are recommended, viz., the plate test method and the mould test method, do not give tests which are entirely free from chill. However, the rate of cooling is not too rapid, evidently, to prevent certain transformations that take place on slow cooling, for it has been shown by a series of comparative tests by the chemists of the Steel Corporation that there is a very satisfactory agreement in sulphur values as obtained by the evolution method on samples taken by these methods and by the sand-cast method. Therefore, it has been decided to adopt these methods as standard procedure where molten iron is to be sampled.

SAMPLING OF MOLTEN METAL FROM THE BLAST FURNACE.

Appliances for Sampling.

A spoon, or ladle, and either moulds or an iron plate are employed in taking samples of pig-iron in the molten state. The spoon is similar to or the same as that employed about the furnaces regularly in taking fracture tests.

Description of Moulds and Plates.—Two forms of moulds are recommended, and the use of either is sanctioned. These moulds are made of cast iron, and are illustrated in detail, with dimensions, in Figs. 1 and 2. Both, it will be noted, are designed so that pieces of approximately the same size may be broken from different tests, thus making it convenient to combine individual tests into one representative sample of any body of molten metal.

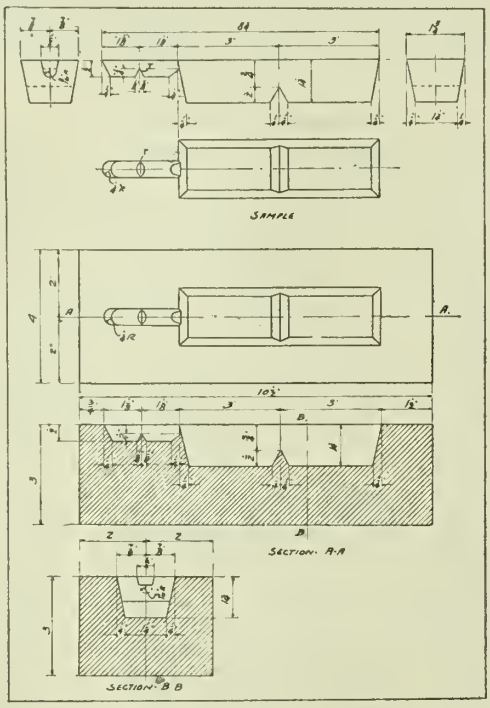


Fig. 2.—Test Piece and Mould for Sampling Molten Pig-iron. Combined Chemical and Fracture Test.

The mould in Fig. 1 gives a test which may be conveniently broken into small pieces suitable for crushing. The number of the furnace may be cast in the mould with Roman numerals, or, if the furnace is designated in another way, some other suitable symbol may be used. The two ridges shown in the test in this figure indicate that the test is taken from furnace No. 2.

The mould in Fig. 2 furnishes a test which may be either drilled or crushed. If the sample is to be crushed, the notched prolongation T is broken and crushed, and the main body of the test is reserved for the furnaceman's fracture test. The furnace number may be cast in this mould, but not so conveniently as the mould described above and only in the main body of the test.

Any iron or steel plate, which has a smooth surface and suitable dimensions, is satisfactory for use in the plate or pat test. As to size, the plate should provide a surface of at least one square foot and should not be less than eight inches in width.

*Method used and published by the Carnegie Steel Company's Bureau of Information, Pittsburgh, Pa., for the United States Steel Corporation.

Accuracy and Care in taking the Sample.

The ladle and mould or plate should be clean to insure an uncontaminated sample, and as a safety measure all the sampling appliances should be perfectly dried immediately before using.

Care should be taken to prevent the inclusion of slag or other foreign matter in the sample. This is accomplished as follows:—Avoiding any material that may be floating on the surface of the metal, a full ladle of iron is dipped from the runner and part of it is immediately poured off, whereupon the test is poured by either of the following optional methods.

Plate or Pat Test.—With the spoon resting on the plate, a pat approximately two inches in diameter or larger is poured thereon. Then, changing the resting-place of the spoon, another pat is poured, and these operations are repeated until all the molten metal in the spoon has thus been poured.

Mould Test.—With the spoon resting on the mould, sufficient metal is poured therein to fill the mould. Only one mouldful may be poured from each spoonful of the molten metal.

Number of Samples to be taken.

A representative sample is the basis of reliable chemical analysis. It is a well-established fact that the first iron of a cast may vary greatly from the iron at the end of the cast. In order to obtain a representative sample, therefore, portions are taken from different parts of the cast, and equal quantities from each portion are combined in one lot. It is evident that each portion should represent the same proportion of the whole cast as any other portion. A convenient method is to secure a sample portion, timed as nearly as possible, from the middle of each ladle of iron in the cast.

Preparation of the Sample.

The test pieces are either drilled or crushed as their size and form requires. In the case of pat tests, the cleanest pat from each portion taken from the cast is selected, care being taken to have all these pats of approximately the same size. If desired, the pats are then broken with a hammer and a representative piece, or pieces, is selected from each and combined so that the sample for crushing will contain about the same amount of metal from each pat. In the case of the mould test, the proper proportioning of the sample is much facilitated by the notches in the test piece, which make it easy to break off pieces of about the same size from the test pieces. When crushed, only that portion of the sample which passes through an eighty mesh sieve is used for analysis.

If the sample is to be prepared by drilling, a test piece cast in the test mould shown in Fig. 2, or one of similar form, is used, and the test piece is drilled to a suitable uniform depth from a cleaned area in its top and through its centre. In this case sieving of the drillings is not permissible on account of the larger proportion of graphite present. Also the drill should be operated to give drillings as fine as practicable, else it will be very difficult to mix the drillings from the individual test piece properly to form the sample for analysis.

Sampling from Truck and Stock Pile.

One pig is selected at random from each four tons of iron, and ten pigs, representing forty tons of iron, or an average car load, constitute a sample unit. This proportion will be found convenient for larger or smaller quantities of iron.

Preparation of the Sample.

The surface of each pig is cleaned with a wire brush or by other suitable means to remove all loose sand. The skin is ground from the centre of the top of each pig, exposing clean metal, by means of an emery wheel. Using a ½-in. twist drill, one hole is made in each pig, starting at the centre of the cleaned space and stopping when the point of the drill appears below. To prevent loss of fine particles during drilling, a sheet metal disc is clamped to the cleaned surface of the pig. There should be a hole in the centre of the disc large enough to admit the drill. The drillings are either brushed off as they accumulate or after the drill is withdrawn. The pig is then inverted over a receptacle to collect the drillings that remain in the hole.

The drillings from the entire unit are combined and weighed. They are then sieved, using 80 and 120 mesh sieves with covers. The portions remaining on each sieve and that passing through the 120 mesh are weighed separately and placed in glass-stoppered bottles, which are appropriately labelled. Each portion is well mixed. A proportionate amount is taken from each bottle for the analysis sample, the exact weight of each depending upon the size of the sample desired.

Example.—The gross drillings of a certain sample weigh 500 grammes, and are separated into portions weighing 400 grammes on the 80-mesh sieve, 80 grammes on the 120-mesh sieve, and 20 grammes through the 120-mesh sieve. In this case, a 5-gramme sample consists of 4 grammes from the portion on the 80 mesh, 0.8 gramme from the portion on the 120 mesh, and 0.2 gramme from the portion through the 120 mesh.

Book Review.

Molybdenum Ores.—By R. H. Rastall, Sc.D. Published by Mr. John Murray, Albemarle Street, London, W. Price, 5s. net.

This book has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute, and forms one of their monographs on mineral resources, with special reference to Great Britain.

The section of the book which will interest foundrymen the most is the uses of molybdenum. As is well known, it is incorporated as a special element in both structural and cutting steels. Additionally, it is used as a constituent in acid-resisting steels, magnet steels and stellite. Since the writing of this monograph, Mr. Oliver Smalley has dealt with its incorporation in cast iron, and the tests certainly show some promise of the regular incorporation of the element for definite purposes. In 1918, according to Dr. Rastall, some 800 metric tons of molybdenum was produced. By 1921 this figure had fallen to a world's output of 7 metric tons. Whilst these world productions seem insignificant, it must be remembered that, when translated into terms of molybdenum steel, the 1918 figure, providing it was all absorbed, assumes some importance, and probably represents over 500,000 tons of steel. We notice that the author has employed lbs. per square inch when indicating tensile strengths. As few British metallurgists visualise tests in these terms, we would suggest that in future editions they are converted to tons per square inch. The bibliography forming an appendix to the book is very complete, and will be of the utmost use for future investigators. Whilst the development of molybdenum has mainly taken place during the last decade, which has in every sense been abnormal, it is pleasing to note that the British Empire has commanded a share, ranging from 20 to 70 per cent., of the world's production. It is Canada and Australia which have provided the British quota.

Another New American Foundrymen's Association.

According to the "Iron Age," an organisation meeting of Indiana foundrymen was held at Purdue University, Lafayette, Ind., November 24 and 25, to bring the foundrymen of the State closer together, for discussion of problems affecting the industry. Mr. Arthur J. Tuscany, secretary-manager of the Ohio State Foundrymen's Association, explained the workings of his Association, and it is probable that an Indiana association will be patterned after it. This is the second association to be formed this autumn in the States. The American Foundrymen's Association do not organise any branches as is customary here, and these smaller organisations fulfil a real necessity, as their national association meets but annually.

Mr. R. A. Miles, Grosvenor Chambers, 24, Deansgate, Manchester, has been appointed representative for the Stanton Ironworks Company, Limited, for the Manchester district.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

Discussion on Mr. J. D. Nicholson's Paper on Dry Sand Moulding.*

Mr. Matthews, after congratulating the author, said he was glad to hear emphasis laid on the inadvisability of putting small patterns in the foundry floor. With regard to the question of ramming, one often saw moulders hitting the pattern with a heavy hammer, and that, of course, was not good for the pattern. He appreciated the remark about the patternmaker's way of concealing important screws, which were certainly true. Boiler stop-valve castings have to withstand great pressure, and sometimes the strain is incalculable, and he quite agreed that chaplets were sometimes used carelessly, and that in such castings they should not be used unless the patternmaker helped by making the cores all in one piece. If possible, the job should be cast with the largest print upwards.

Mr. Oakford referred to the question as to whether a grate should be placed with the narrow or the broad side down. He thought that one was compelled to use the side which happened to be convenient, according to whether it contained stirrups or not. As far as stirrups were concerned, the narrow side should be down in the top box.

Mr. Nicholson said that in making a few grates eyes are not always cast in.

Mr. Frier said that he was very pleased to hear Mr. Nicholson's Paper, particularly as he was one of his own boys. The fact of his writing such a Paper showed that he had been really taking an interest in his work and had taken notice of what he had been told, and at the same time it showed that he held opinions of his own. There were several things which Mr. Nicholson had embodied in his Paper which had been well thought out, and he (Mr. Frier) was not ashamed to admit that they had been thought out and adopted without any reference to him. A foreman, no matter how clever a man he is, should never refuse to accept recommendation and advice from his men. He particularly hoped to hear some of the boys say something, because he thought that a lecture like this ought to open ample discussion.

Ash Venting.

Mr. James Smith said that he was glad to hear Mr. Nicholson's Paper, because he had always preached that the practical man was the essential man in the foundry. With reference to the engine stop-valve which was made with brackets, Mr. Nicholson had expressed the opinion that the difficulty of bracket scabbing could be overcome by inserting a few ashes and venting the sand. He agreed that that was possible with a green-sand mould, but not with dry sand. He remembered about 35 years ago, when first marine engine work was transformed from loam to dry sand, there was a great difference of opinion as to how the bottoms of moulds should be made to withstand scabbing. He was speaking of the time when the old-fashioned condenser was used, and, naturally, from his green sand experience, the first thing that the moulder did when he commenced on this work was to put a big cinder bed on the flat bottom about 10 to 15 in. from the face of the mould, and when the bottom was finished he would push in a wire pricker. For some years they had had difficulty with scabs, and one day when he (Mr. Smith) was busy with a condenser he decided not to put a cinder bed underneath it, and when the casting was turned out it was exceptionally clean. The reason was this: When a pricker is pushed right down to the cinder bed the large fires naturally draw the dampness from the ashes right through to the face of the mould. Now they never put in a cinder bed at all, because if the mould had to stand for a time the steam would gather on the face of the mould. To illustrate that point, he said at that time the condenser tops were put on the night before, and when the tops were taken off the next morning he had seen drops of water on the mould. He agreed that a cinder bed could be used with a green-sand mould, but if a dry sand mould is thoroughly dry there would be consistently good results.

Mr. Nicholson, in answer to Mr. Smith, said that the engine stop-valve which he had dealt with was in a box and not in the floor. The hole which he had mentioned was about 1½ in. dia., and when the metal entered the mould the air rushed to this hole, as it provided an easy exit.

Wire Pricking.

Mr. Frier remarked, with regard to venting, that they had had trouble with the wire pricker, but had abandoned the use of it, and obtained a better face on the bottom of the casting on that account. They never used one now, irrespective of the size of the mould, and a cinder bed was not made unless vents had to be carried through the bottom of the mould.

Mr. Brailsford said he wished to draw attention to the placing of a dry-sand mould on bricks, after it had been taken out of the stove. His experience had been that the placing on bricks caused trouble, particularly in the case of a large casting which had been placed on about 12 in. of bricks, and the trouble lay in the fact that it fell through the bottom. He agreed with Mr. Nicholson in the method of bringing air off the mould with the brackets and the bole, and had seen the same method used for very large feet and brackets of condensers where they had a coke bed with a hole from the bed to the joints. In the North there was more trouble with scabbing, owing to insufficient venting, than there was in the Midlands. He, personally, had seen moulders making dry sand jobs for iron, as well as for gunmetal and other alloys, without putting a vent in, declaring that it was not necessary. He (Mr. Brailsford) thought it was quite as necessary for the air to be brought off a dry-sand mould as off a green-sand mould.

Mr. Nicholson said that a box put on a sand bed drew dampness from the sand.

Mr. Smith said that he failed to see how boxes coming out of the stove would draw dampness, because the steam could be seen coming off as soon as the vents were made.

Methods of Drying.

Mr. Paulin said the author had referred to the question of the moulds not always being dried in stoves, but sometimes being dried in position, especially if the job was bedded in the floor. The methods of drying raised excellent points for discussion. There was, for instance, a method of drying based on the air being forced through the coke fire contained in a closed vessel, and the products of combustion being led through a pipe into the mould. With regard to stove drying, had Mr. Nicholson noticed any difference between drying in front of an open fire by means of fresh air and drying in a closed stove? Had any member had experience of the use of Bunsen burners for drying? The author had touched on the question of ramming hard, and had referred to the fact that the introduction of core oils had robbed young men of a great deal of experience in core-making, but if experience was lost in that particular place it was obtained in other directions. The lecturer had also referred to guides and marks on boxes. Instead of making just one flange and pin, he had seen a method of making a double flange and a loose pin simply slipped right through. He considered that this was a most effective method of correcting the slackness of boxes. The lecturer had referred to the great trouble of hanging parts in top boxes. The application of core oil was well worth consideration, as a lot of hanging parts were eliminated, being replaced by cores.

Mr. Nicholson replied that the practical man knew that too much claywash was detrimental and would not empty a bucketful over a loose piece of mould. With regard to cores, the coreing out of awkward parts would assist moulders in some

* This Paper was published in our last issue.

cases, yet they would have to be fastened and made rigid in the top parts, and with reference to pins in boxes he said that moulders did not like them because one side of the box might jam and cause trouble.

Scabbing Troubles,

Mr. Murray asked with reference to the mixture of loam and sand, whether Mr. Nicholson ever had trouble with scabs.

Mr. Nicholson replied that he never had scabs when using loam mixed with sand on the head valve casting, the reason being that the grates were there and the loam was strong enough to hold itself. Any steam caused through the molten metal was forced to rise through the sand.

Mr. Smith said that if loam was put round the joints and a grate put on, the mould would be dried—therefore, what was the difference between that and a dry sand mould?

Mr. Nicholson said that he was meaning mixing sand with loam, and "one does not get scabs on joints."

Mr. Smith said that Mr. Nicholson had first spoken about making loam joints to secure a clean lift, and if loam was mixed with sand the loam must be dry.

Mr. Nicholson replied that the loam was mixed with the milled sand by hand and put on the pattern, not on the joint.

Joining Loam to Sand,

Mr. Murray explained that what he had meant was that the wet loam would not combine with the sand, and when dry there would be a crack between the loam and the sand unless sprigs were used to keep them together.

Mr. Frier said that if one put milled sand next to the loam they would adhere together, but common floor sand would not.

Mr. Lillie said that they had carried out the method of mixing milled sand with loam in the brassfoundry without difficulty. There was not any need to worry about the mould being on a sand bed after it had been dried in the stove because it would not absorb sufficient moisture from the bed to affect the casting.

Mr. Nicholson replied that when the box was sitting on a bed steam would rise through the pricker holes to the mould face.

Mr. Smith referred to the venting of moulds. Mr. Brailsford had said that in his opinion there was not sufficient venting done in the North. Was he referring to dry or green sand moulds? If the sand was thoroughly dried it did not need venting, but green sand had to be vented as much as possible. In the foundry he would not allow a vent to be made in sand mould, *if it was dry*, because it was not necessary.

A Member said that he had seen dry sand castings which were badly scabbed.

Mr. Smith suggested that the scabs could not have been caused by lack of venting but through the sand not being dry.

The Member replied that he would not say that the sand was not dry, but in many cases it was impossible to keep the moulds in the stove until perfectly dry because it would hinder other work; therefore, vents had to be used to get the moulds bone-dry, and he considered that with vents one obtained a better skin on the casting.

Mr. Lillie said that he had never known men to plug risers in a brassfoundry, as they had never found any necessity to do so, whether the mould was dry or not.

Mr. Smith said that he had seen the risers blow off large green sand moulds, the air rushing out necessarily brings down a green sand top. When casting a green sand mould the risers should be kept closed. If it is a large casting, a weight, with a hook to lift it by, should be placed on the risers and then there would be no fear of them blowing off as before.

Another Member said that he thought that a green-sand mould should be vented with a vent-wire, and when the mould was closed the risers should be kept tight because the gases which were generated must leave by these vent wire holes; but if the risers were not kept tight, the air would take the easiest course out and make for the risers and probably blow out the bottom of the mould.

Senior Surtees Medal Not to be Awarded,

Mr. Young, in closing the discussion, said that trade had been very bad this year, and consequently a larger number of moulders were without work. Probably 99 per cent. of these men did no serious work, but Mr. Nicholson had written this Paper and had enjoyed doing it. He (Mr. Young) considered that this fact placed great credit on Mr. Nicholson's Paper, as one is naturally not so interested as when actually doing the work. It is remarkable when writing a paper the number of things one does not know and has to look up. Another thing he would like to point out was that Mr. Nicholson had done all his own drawings, which were exceedingly good ones. From all the foundries on Tyneside, Mr. Nicholson was the only senior candidate for the Surtees medal, and therefore no examination would be held and no award given. A vote of thanks to the lecturer was then accorded.

Recovery of Molybdic Acid and Preparation of Ammonium Molybdate Solution from Ammonium Phospho-Molybdate.*

In methods when ammonium molybdate is employed as a precipitant, an economy may be effected by recovery of the molybdic acid from the filtrates. In case recovery is desired, washings from the operation of filtration are not permitted to mix with the filtrate proper, but the latter is transferred to a suitable container, for reservation, before washing of the precipitate is begun.

When a convenient quantity of the filtrate has been accumulated it is heated to boiling, and a solution of commercial sodium phosphate is added. The weight of sodium phosphate in this solution should be 10 times the quantity of 85 per cent. molybdic acid to be recovered, or 33 grammes of sodium phosphate for the equivalent of each 50 c.c. of ammonium molybdate solution treated. The solution is allowed to stand until the precipitate of phosphomolybdate has settled; it is then decanted and the precipitate is transferred to a wide-mouth bottle of 5 litres capacity or larger. These operations are repeated until a sufficient quantity of the yellow precipitate has been collected, when it is washed by decantation with nitric acid (1:50). It is then transferred to a large dish, and the liquid is evaporated. When dry, this precipitate, or a mixture of this precipitate and molybdic acid, is employed for the preparation of ammonium molybdate solution. The recovered phosphomolybdate contains 92 per cent. molybdic acid; hence, when used alone, 60 grammes are sufficient to make one litre of the solution.

Ammonium molybdate solution is prepared from recovered phosphomolybdate as follows: Sixty grammes of the phosphomolybdate are dissolved in 230 c.c. of water and 170 c.c. of AmOH. A solution of 10 grammes of commercial magnesium nitrate or sulphate dissolved in 30 c.c. of water is now added to precipitate the phosphate. The flask is shaken and the precipitate is allowed to settle, whereupon the solution is filtered and the precipitate is washed with 30 c.c. of ammonia (1:4). The filtrate is cautiously added to 540 c.c. of nitric acid (1:1). The solution is now ready for use as needed.

The monthly ascertainment under the sliding scale in operation in Cumberland and North Lancashire shows that the average selling price of Bessemer mixed numbers of hematite pig-iron for November, 1922, was 91s. 9d. per ton, an increase of 1s. 5d. compared with the previous month. Blastfurnacemen's wages on the West Coast accordingly rise by 1 per cent. to 31½ per cent. above standard, and bonus earnings in West Cumberland to 64½ per cent., and in the Furness district to 59½ per cent. This will take effect as from the commencement of the second full pay in December.

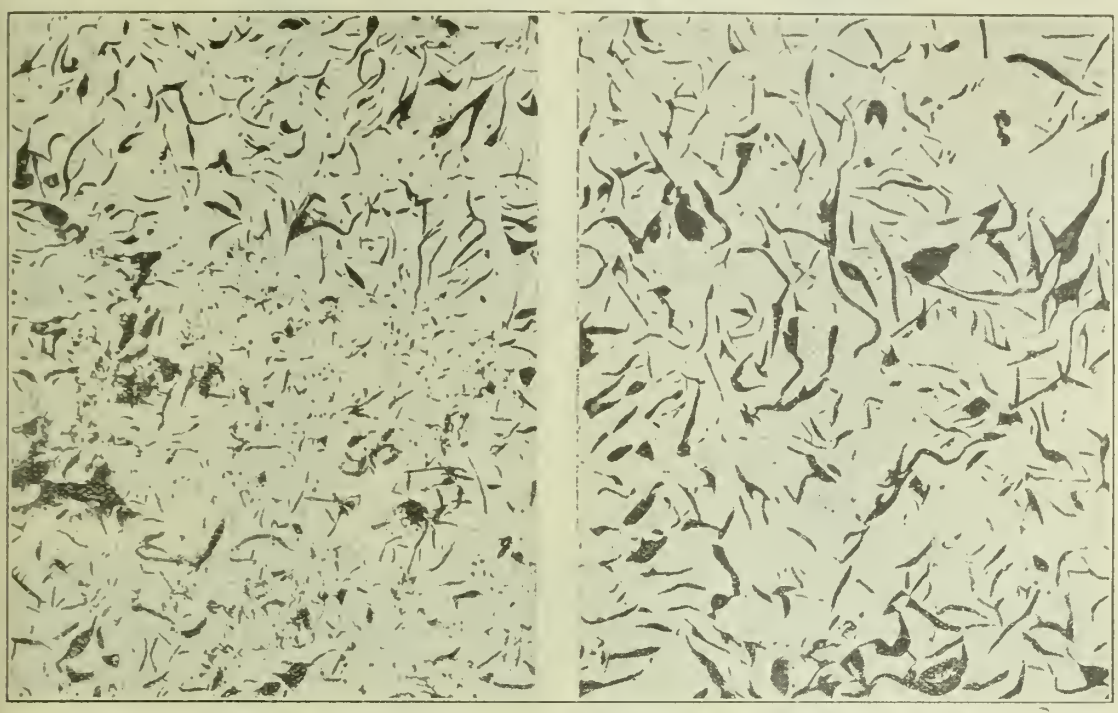
* A method used and published by the United States Steel Corporation.

The Effect of Special Elements on Cast-iron.*

By O. Smalley [M.I.Brit.F.

The scope of this paper will be confined chiefly to the carbon problem of cast iron and to present some exploratory experiments on the effect of various special metals, such as Cu, Ni, Cr, Mo, W, etc., on the quantity and form of the graphite and to consider briefly the commercial possibility of direct manufacture of alloy malleable from the cupola.

In ordinary cupola-melted grey cast iron the graphite content varies between 2 and 3.9 per cent. This represents approximately 5.2 to 10.5 per cent. of the total volume of the iron, and being in effect, so far as strength and toughness are concerned, equivalent to so much space distributed as tiny worm-like cavities. It requires no stretch of the imagination to appreciate the far-reaching influence of small variations of graphite on the physical properties, and the importance of accurate control of both the quantity and mode of distribution. Yet it is singular that even to-day these two factors receive but scant consideration and it is not uncommon to find investigations on the effect of special elements published, which do not even consider the carbons present. To some extent this is explained by the fact that the quantity of total carbon, hence the graphite content, is a variable difficult of control and affected in the daily melt by such factors as :— (1) The percentage of total carbon, graphite content, and its physical form in the original pig melted: (2) design of the cupola; (3) quality of coke used; (4) depth of coke bed; (5) proportion of blast to coke; (6) coke to iron ratio: (7) temperature of melting: (8) rate of melting and so on. And being associated as it is with so many other variables, there is some difficulty in taking it into account at all and one recognises the diffidence of any investigator in publishing his results.



Figs. 1 and 2.—Showing the Micro Structure, Magnified 50 Times, of Close and Open Fractures of a Grey Iron Casting.

Physical Form of Graphite.

Recent research proves that graphite in cast iron possesses the same crystalline form and undergoes the same allotropic changes as ordinary mineral graphite. It is usually contaminated with both the gaseous and the solid foreign matter in the iron. According to Moissan it is of the swelling type. Graphite possesses varying degrees of refractoriness and lubricating qualities, according to temperature and other conditions of manufacture. For fuller information reference should be made to the researches of Moissan.

Grading of Pig-iron.

Silicon considered in conjunction with the quantity and form of the graphite is the commonest method of grading pig-iron and controlling the texture of iron castings. Each of the other common elements, Mn, S and P, certainly receive due consideration, but more often from the question of the production of clean sound castings and cost. Sulphur, the *bête noir* of cast iron, figures more prominently in the mode of distribution of the carbon than is generally appreciated, and, under control, is of the highest value as a strengthener and grain-refiner. The average melter, however, is better satisfied in keeping this element on the low side, rather than make use of it.

Mass Effect.

That the rate of cooling during solidification is an important factor controlling the form of the graphite, with which is associated the texture, is generally recognised, but like the sulphur problem, it has been insufficiently investigated, and is therefore not fully understood. There exists, however, for every grade of grey cast iron a certain critical rate of cooling, which yields, within practical limits, the same grain or density, regardless of section or dimension of the casting.

This method of control certainly possesses definite limitations, but it presents an immediate solution to the pig-iron problem. When once the importance of control of the rate of cooling during solidification is fully understood, not one per cent. of present-day troubles arising from open texture and porous patches—defects all too common to large castings and castings of varying sections—will be encountered. The mass effect problem, being beyond the scope of this Paper, cannot be adequately treated here.

Solubility of Carbon in Molten Iron.

It is commonly asserted that graphite is necessarily a decomposition product of the carbide, and does not exist as such in molten iron—a controversial problem which would be all the better for

* A Paper read before the Sheffield Branch of the Institution of British Foundrymen.

airing and closer investigation. In fact, until more information is forthcoming on the nature of the solution of carbon in iron, which will admit of a working theory, one cannot investigate such problems as are mentioned in this Paper, save by laborious, exhaustive, practical experiments. Consider this problem for a moment. If all carbon in molten cast iron exists as carbide, should not a regular rate of cooling deposit graphite in a regular form, instead of yielding irregular masses suggestive of a mechanical deposition? Why, as a general rule, is it found that the higher the casting temperature of grey cast iron, the better the test-results and the closer the grain? It is not a result of the quantity of carbide formed? The author has not been able to associate the combined carbon-content in grey iron with either strength or texture, and there is no general agreement as to the desired combined carbon-content necessary to the highest strength. True alloys do not behave in this way, and, according to the solution theory, molten cast iron is a true alloy. Columnar crystallisation common to solid solutions is practically unknown in grey iron, no matter how drastically cooled, and die-casting with an iron containing a total carbon-content under alleged saturation is quite a commercial possibility. In the author's experiments he has never been able to quench a grey iron from the molten state sufficiently drastic as to retain all the carbon in the combined state. Recent metallographic research of the carbide suggests the carbon to exist in the atomic form.

Do not all these facts indicate that grey iron differs from white iron only in that free graphite exists in the molten iron in the former, but not in the latter? Again, is not the question of the

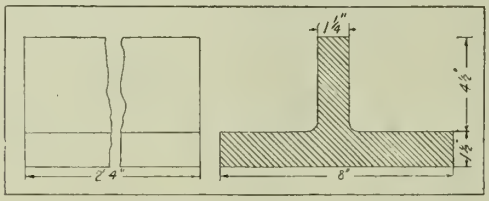


Fig. 3.—Form of Test-piece Used.

solubility of graphite in cupola-melted grey iron closely connected with the form and quantity of the graphite in the pig melted? If a coarse-grained graphitic iron is melted, the castings are neither as strong nor as tough as those obtained from close-grained irons of the same chemical composition. Is it not that coarsely-disposed graphite in pig iron may not completely dissolve in ordinary cupola-melted iron, but retains a ghost-like outline of its original form in the molten iron, and so reproducing the original coarse structure of the pig in the finished casting by this free graphite acting as nucleus for the deposition of more free graphite during solidification—a view the author expressed in a Paper* read to the Newcastle Branch?

Briefly and simply stated, do not the foregoing facts justify the suggestion that graphite is merely mechanically suspended in molten grey iron, and the colloidal theory present a working foundation for the study of the effect of special elements considering each quantitatively, either as a coagulating or peptising agent? Does not this theory also present a working foundation from which one may systematically investigate the problem of manufacture direct of cupola malleable?

Grain Refining Experiments.

Foreign Matter.—Figs. 1 and 2 show the microstructure of a close and open fracture from the same section of a casting. The explanation of the difference in grain is seen to lie in the different form of the graphite flakes. In Fig. 1 the presence of excess sulphide of manganese is evident, and in Fig. 2 it is absent, suggesting that each particle of insoluble sulphide functions as a centre for the deposition of graphite; hence the bunch effect shown.

Effect of Special Elements.

Carrying this reasoning further, is it not logical to suppose that the introduction of some higher melting-point constituent of about the same density, distributed uniformly in a fine state of division, would be equally effective in reducing the dimensions of the graphite flakes throughout the mass in the same way? Such a method certainly presents practical difficulties; oxides, silicates, sulphides may function in this way, but, apart from difficulties due to segregation, they are objectionable on other grounds. With the exception of Cu., all base metals worthy of consideration combine with C. and dissolve readily in molten cast iron.

Pure iron, alloying with Cu. and giving rise to a high melting-point constituent containing about 8 per cent. Cu. of approximately the same density as molten cast iron, suggested itself worthy of trial if it were introduced in the ladle and not in the cupola.

To test the practicability of this, and also to investigate the relative grain-refining effect of other special elements, it was decided to cast a series of test bars, of the form shown by Fig. 3, from an ordinary grade of iron of the following chemical composition:—Total Carbon, 3.2 to 3.6 per cent.; Si., 2.0 per cent.; Mn., 0.7 per cent.; P., 0.8 per cent.; and S., 0.10 per cent. It was made from 6 parts of Cleveland No. 3, 5 parts of hematite mixed, and 8 parts of hematite scrap. This mixture has a good fluid life, and yields clean castings, but is objectionable on the ground of open grain.

Six moulds were prepared in dry sand and placed side by side, the temperature at the time of casting being controlled at 100 deg. Fah. (37 deg. C.). Thirty hundredweights of this metal was tapped from an 8-ton cupola into one ladle, at a temperature of 1,380 deg. C. From this, six 3-cwt. ladles were filled, introducing the necessary additions. The pouring temperature of each cast was controlled at 1,300 deg. C. Details concerning each special metal will be given under its distinctive heading. Each experiment was repeated twice, and in some instances three times, in order to obtain true average results, sectioning the bars through the centre for structural examination and hardness tests.

Influence of Copper.

This was introduced by means of a 20 per cent. Fe. (Cu.-Fe.) stock-alloy in stick form. The ladle was well stirred, and stood for about five minutes before casting.

Prints 1 and 2 (Fig. 4) depict the structural change wrought by the addition of 0.5 Cu. This confirms the anticipated results.

Under the microscope no special constituent could be traced, despite the non-alloying properties of Cu. with cast iron, although this does not prove its absence. It will be observed that accompanying the introduction of small quantities of copper there is a slight increase of Brinell hardness, although the tendency for the combined carbon-content is to fall.

Influence of Nickel.

Nickel alloys with iron in all proportions, but reduces the solubility for C. and renders the carbide somewhat unstable, *i.e.*, it facilitates the conversion of carbon from the combined to the free state. Bauer and Piwowarsky* showed, however, that up to 1½ per cent. of Ni. is beneficial in cast iron, increasing the transverse strength 30 per cent. without affecting the deflection, raising the compressive strength 30 per cent., the tensile strength 25 per cent., and the hardness 18 per cent. Quantities above this cause segregation of the graphite, which more than counter-balances any toughening or refining action that it may have on the ferrite grain and on the form of the pearlite. Witman† made use of this fact by introducing 5 per cent. Ni. into cast iron for the manufacture of electric resistance grids of small section, which must be soft, show an open grey fracture, be resistant to shock and stand up well under rough usage. He claimed that an alloy of the following composition met all these requirements:—TC, 3.6 to 4.0 per cent.; Si, 2.4 to 2.6 per cent.; S, under 0.05 per cent.; P, under 0.08 per cent.; Mn, under 0.46 per cent.; Ni, 4 to 5 per cent.; Cu, 0.5 to 0.7 per cent., and that the casting

* Foundry Trade Journal, May 4, 1922.

* Stahl und Eisen, September 30, 1920.
† A.I.M.M.E., August, 1921.

may be twisted cold into various shapes, taking a permanent set before breaking.

Print No. 3 (Fig. 4) shows the denseuing effect of 0.50 per cent. Ni on the structure of ordinary grey iron. This was cast under the same conditions as the copper alloy, introducing the Ni into the ladle in the form of shot, and allowing to stand 4 min. after well stirring. Microscopical examination confirmed the macro-etching, and showed the change to be one of dimension of the graphite flake, there being little or no combined carbon present. According to the Brinell figures, this quantity of Ni has little or no effect on the hardness.

Influence of Chromium.

Little systematic investigation has been conducted on the effect of Cr on cast iron. It is well known that Cr exists in a state of solid solution in pure iron. In steel it gives rise to a double carbide of Cr and Fe—$(Fe_3C)\ x\ (Cr_3C_2)y$—which varies according to the Cr content. As the Cr rises the proportion of Fe_3C falls, and it is thought that in the presence of over 5 per cent. Cr a third carbide forms Cr_4C, eventually replacing the Cr_3C_2. Cr, in contradistinction to Ni, thus increases the solubility for carbon, and opposes the dissociation of the carbide into its component parts, and for which reason is an effective hardener. Klep concludes from a brief investigation that very little benefit accrues from the addition of Cr. Campion* has shown that 1 per cent. Cr slightly increases the tensile strength and transverse strength without affecting the hardness. He has also shown that this quantity of Cr increases the combined carbon-content from 0.831 to 1.094 per cent.

In the present exploratory grain-refining experiments, 0.5 per cent. of Cr was introduced by means of a molten 65 per cent. Cr, ferro-chromium alloy. This was well stirred, and the ladle of metal allowed to stand 4 min. before casting.

Etching No. 4 (Fig. 4) shows that this quantity not only closes the grain, but improves solidity and increases the hardness throughout, the centre of the thickest section having the Brinell hardness and solidity of that of the thinnest section of the same iron without Cr. This, together with other preliminary experiments with Cr, were very promising and considered in conjunction with its remarkable value in steel in improving wear, imparting great strength at high temperatures, eliminating oxidation at high temperatures and its invaluable rust-resisting properties, a more detailed investigation of the effect of varying quantities of Cr on ordinary cast iron was considered worth while, and the results are included in a separate Paper.

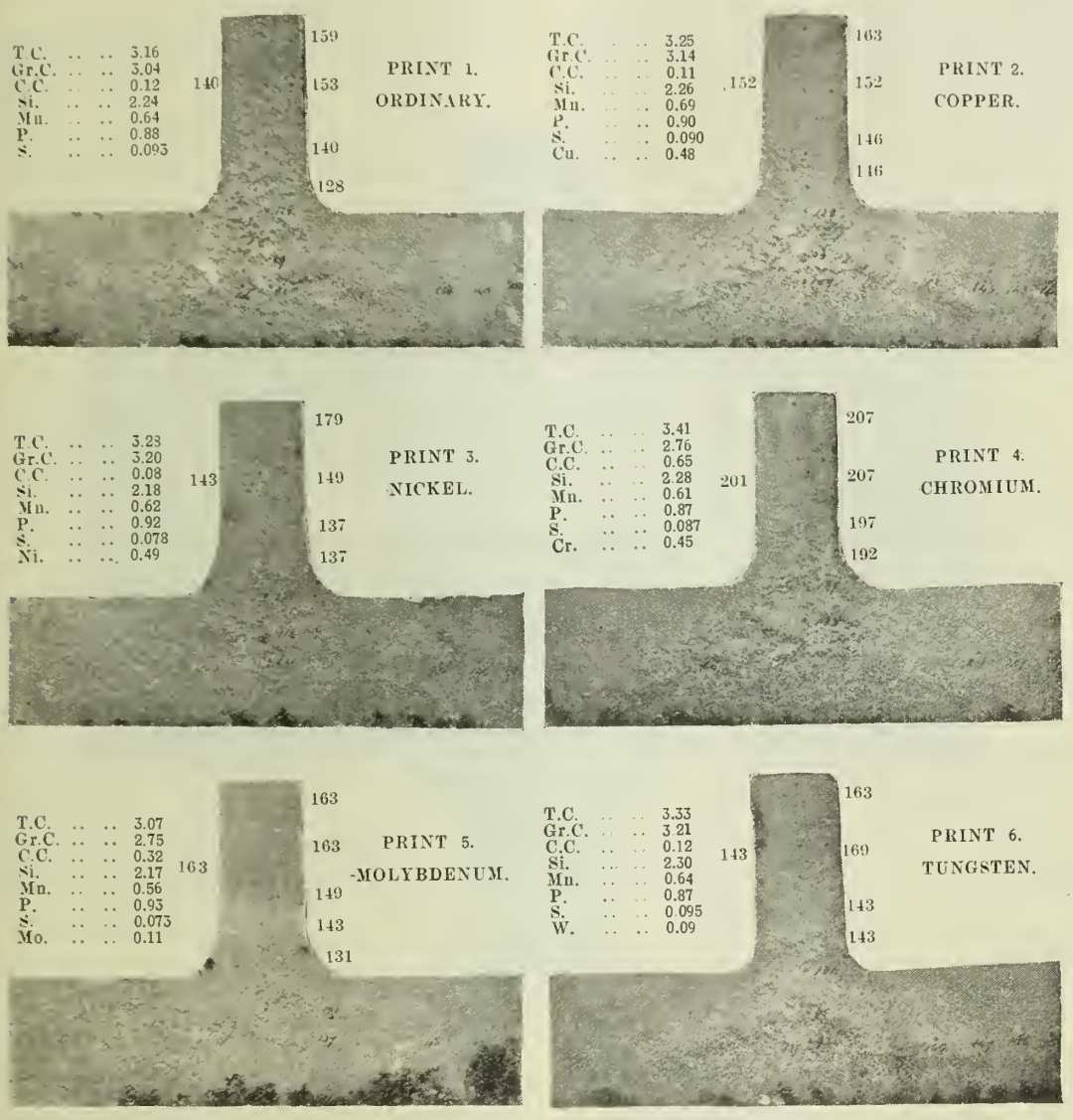


Fig. 4.—Prints from Various Alloy Castings.

Effect of Molybdenum.

Mo, like Cr, is of proved value in steel, but little is known of its effect on cast iron. In steel it combines preferentially with the ferrite, and forms a solid solution of Mo and Fe, although it combines with the carbon, forming a double carbide of Fe and Mo, which fairly readily dissociates. This points to the fact that Mo might play the dual rôle of both Ni and Cr, and results of such exploratory tests as had been made were keenly anticipated.

In the grain-refining experiments under discussion 0.10 per cent. Mo was introduced by means of molten 8 per cent. Mo, ferro-molybdenum, well stirring, and then allowing the ladle to stand 4 min. before casting.

* B.F.A., 1918.

Etching No. 5 (Fig. 4) shows this percentage of Mo to have closed the grain without appreciably affecting the hardness.

Fig. 5 shows a fracture of this Mo iron, together with the ordinary grey iron, for purpose of comparison. Campion,* working with a somewhat harder iron, showed 1 per cent. Mo to increase the strength and reduce the hardness.†

Influence of Tungsten.

Prof. Campion‡ reviews the work of past investigators on the effect of W on cast iron, and publishes some experiments which show 1 per cent. W, increases the strength, but reduces the Brinell hardness.

The brief exploratory tests which the author has made in this field of research, by introducing 0.10 to 1.0 per cent., did not reveal features sufficiently outstanding to justify exhaustive investigation.

Etching No. 6 (Fig. 4) shows the effect of 0.10 per cent. W on the grain of ordinary grey iron.

The W was introduced by means of a 3 per cent. W ferro-tungsten alloy, in the molten state, the other conditions being similar to those outlined in the Mo experiments. In many respects it behaved like Mo, with the exception that the section was by no means so uniformly solid throughout, although it was an improvement on the ordinary iron (etching No. 1, Fig. 4).

As far as hardness is concerned, 0.1 per cent. W, similar to a like quantity of Mo, exerts little influence.

Conclusions.

These experiments, whilst only exploratory, briefly demonstrate the relative values of various special elements as denseners of common soft grey cast iron, and suggest that the introduction of small quantities of Cu, Ni, Cr and Mo are efficacious in helping to eliminate coarseness of texture and sponginess.

DIRECT MALLEABLE CAST-IRON.

At some time or other most foundrymen have turned their attention to the problem of the manufacture of malleable cast iron direct from the cupola. It is a problem of engaging fascination, and it is proposed to consider briefly the possibilities of development by the introduction of special elements.

Possibility of Copper.

Very little information has been published on the effect of Cu in any quantity on cast iron. Being a ductile metal, and having no chemical affinity for carbon, Cu naturally suggests itself worthy of consideration. For the present investigation a hematitic pig-iron of the following chemical composition was chosen:—TC, 3.3 per cent.; Si, 2.0 per cent.; Mn, 0.70 per cent.; P, 0.08 per cent.; and S, 0.03 per cent. Electrolytic Cu was used, the melting being performed in a crucible furnace, using 5 lb. of iron and adding 5, 10 and 25 per cent. Cu respectively. Each was well stirred and cast in bars 6 in. × 2 in. × ½ in. in dry-sand moulds.

Bending tests on the 5, 15 and 25 per cent. copper alloys gave 0.10, 1.0 and nil degs. respectively, whilst the fracture of the 5 per cent.

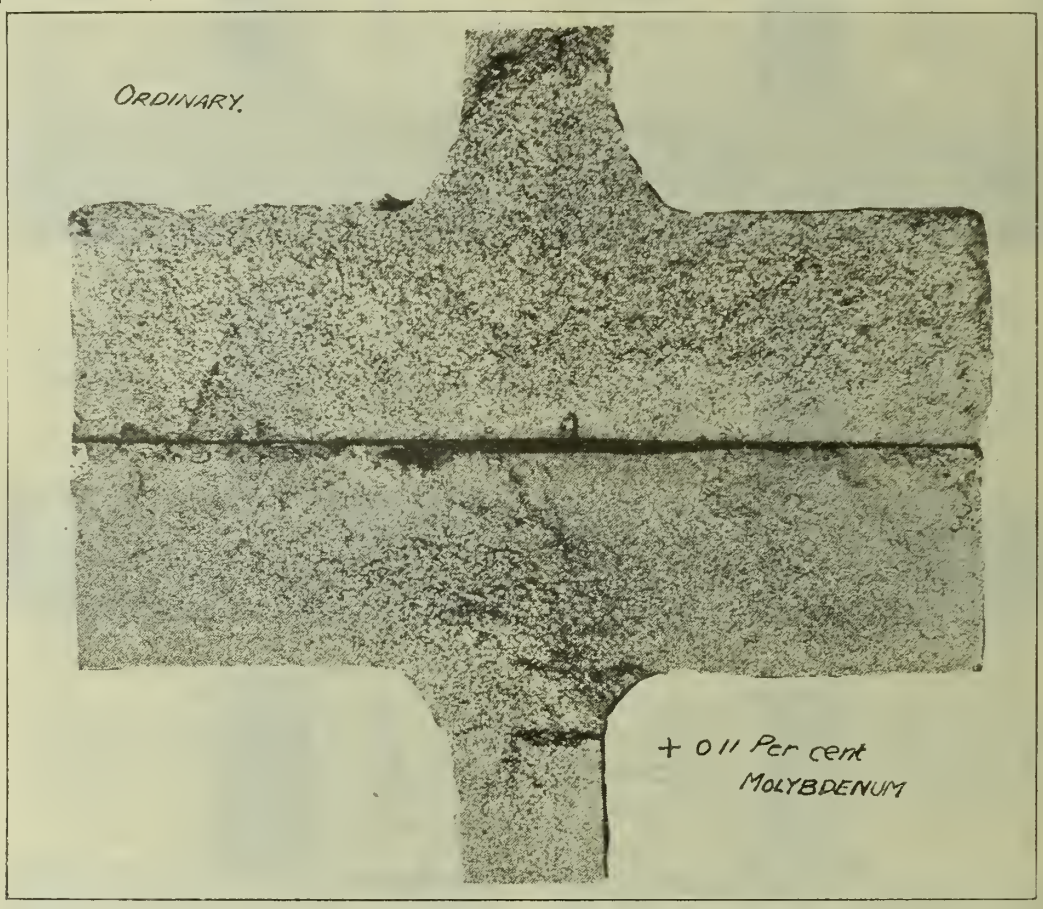


Fig. 5.—Fracture of Molybdenum Compared wit h Ordinary Grey Iron.

alloy was grey; the 10 per cent., fine grey; and the 25 per cent., fine grey speckled with yellow.

Microscopical Examination.—In the 5 per cent. alloy the copper was shown to be well distributed, and the graphite was present in fine flakes. So, too, in the 10 per cent. alloy, the copper was uniformly distributed, but the graphite was in nodules and small flakes. In the 25 per cent. copper alloy the copper was distributed in coarse patches, suggestive of segregation, and the graphite was nodular, with only traces of flakes.

No good purpose to be gained by exceeding 10 per cent. Cu. Above this amount the alloy is distinctly sluggish, and the Cu-rich constituent inclined to segregate. There is, however, no doubt that 5 to 10 per cent. Cu serves a useful purpose in reducing the total carbon content, breaking up the flakes of graphite and imparting toughness.

Prospects of Aluminium.

In some preliminary experiments small percentages of this metal were found to reduce the quantity of combined carbon, and to increase the graphite content. Rhead suggests that Al is

* B.F.A. Proceedings, 1919.
† Subsequent experiments with this element have been sufficiently interesting and promising to justify a closer investigation.
‡ Proceedings, British Foundrymen's Association, 1917–1918, pp. 85–86.

responsible for depositing the graphite in a finer state of division. In the present research two casts of hematite were prepared, introducing 3 and 6 per cent. Al respectively. The 3 per cent. alloy gave no bending angle. It possessed a fine grey fracture, whilst the microscopical examination showed the Gr. to be in a fine state of division, and a white hard constituent was present, distributed in dendritic form. The 6 per cent. alloy was dead brittle, and had a glazed fracture. No Gr was present, the microscopical structure being not unlike that of a badly-annealed steel casting. The Brinell numbers were 277 and 489 respectively. The 6 per cent. alloy was annealed at 870 deg. C. over various periods of time, but the most drastic annealing failed to produce any graphite. The alloy, however, was unaffected by oxidation, and has since been found to possess remarkable non-scaling and non-rusting properties.

Nickel Experiments.

Two casts were made introducing 5 and 7 per cent. Ni by means of shot nickel. The former, on bending, broke at 0.10 deg., giving a fine grey fracture. The microscopical examination revealed coarse flakes of Gr and a Ni-austenitic solid solution. With 7 per cent. nickel, 1.5 deg. were shown on bending. The fractnre was of a mottled character. Under the microscope the Gr was finer than the 5 per cent. alloy, and a larger quantity of the Ni-austenitic matrix was present. No improvement in the bending angle was obtained by long annealing either alloys.

Ni and Cu Combined.

From the experiments so far conducted Ni and Cu were the only two metals suggesting themselves worthy of development.

For this further investigation a series of irons with various combinations of Ni and Cu were prepared. The two most promising were a 7 per cent. Ni-3 per cent. Cu and a 10 per cent. Ni-10 per cent. Cu, introducing them by means of a Ni-Cu stock alloy. The former alloy bent 3 deg. before breaking, and the latter 7 deg. Their fractures were "fine grey edges inclined to be silky" and "very fine grey silky edges" respectively. Examined under the microscope, the 7 Ni-3 Cu alloy was shown to have the Gr in nodular form and a Cu-rich compound, finely distributed in a Ni-austenitic matrix, was also apparent. The 10 Ni-10 Cu alloy, however, showed only a little nodular Gr, but there was present a free Cu-Ni compound, evenly distributed. Neither was improved by annealing.

Further experiments with Cr and Al additions in conjunction with Ni and a varying Si content were conducted, but with no promise.

The foregoing investigation, although brief, goes far to indicate the difficulties confronting the development of alloy malleable, and leads one to believe that, even if produced in the cupola on these lines, their commercial value will be severely restricted by the cost of the special metals necessary.

Tentative Specification for Tool Steel.—A tentative specification for carbon tool steel has been proposed by the American Society for testing materials. It requires that the steel shall be made by either or both the crucible and electric processes, with the exception of class *C*, which may also be made by open-hearth methods. The steel shall conform to the following chemical composition, carbon varying and the following maxima:—

	Class *A* per cent.	Class *B* per cent.	Class *C* per cent.
Manganese ...	0.400	0.450	0.600
Phosphorus .	0.020	0.025	0.035
Sulphur	0.025	0.035	0.040
Silicon	0.350	0.350	0.250

The carbon percentage shall be as ordered, the specifications varying by ranges of 0.1 per cent., with rejection limits plus or minus 0.025 per cent. The permissible variations in the size of the material ordered shall be determined by agreement between contractor and purchaser. The material shall be free from injurious defects and have a workmanlike finish. The analysis shall be made in accordance with methods for testing carbon tool steel contained in the Book of the American Society for Testing Materials, Standards of 1921.

Blue Constituent in Manganese-Bronze.

In a Paper which Mr. E. H. Dix presented to the American Institution of Mining and Metallurgical Engineers the following conclusions have been drawn by the author:—

1. When the hardening elements (aluminium, tin, iron and manganese) are added to the 60-40 copper-zinc alloy in sufficient quantities to produce a high-strength manganese bronze, a third constituent appears in the alphabeta prime complex which has a characteristic clear blue colour.

2. The occurrence of this constituent in reasonable amounts is not necessarily accompanied by brittleness.

3. Annealing for 7¾ hours at 815 deg. C., followed by either water quenching or slow cooling, does not cause the disappearance of this constituent.

4. This constituent, when examined unetched, appears to be of a deeper blue than either the delta constituent of the copper-tin series or the gamma constituent of the copper-zinc series. When etched with NH_4OH plus H_2O_2, the blue constituent is unattacked except for a slight eating away at the edges under prolonged etching, whereas the gamma constituent with the same reagent is immediately tarnished and rapidly dissolved. The characteristic shape of the blue constituent is decidedly different from that of the delta of the copper-tin alloys.

5. For practical purposes in the study of the microstructure of manganese bronzes, it seems highly desirable to regard the blue constituent as distinct from either the delta or gamma, and it is suggested that it may reasonably be denoted as delta prime.

6. In the manufacture of manganese bronze the particles of delta prime are precipitated from the copper-rich solution by the addition of the zinc. This precipitation is strongly influenced by the presence of iron and, therefore, the particles probably consist of a solid solution of iron and copper with or without some tin, aluminium or manganese.

New Installations of Electric Brass-Melting Furnaces.

According to the "Iron Age," the Detroit Electric Furnace Company, Detroit, has arranged to supply a 2,000-lb., 300-kva. Detroit electric brass melting furnace for the Ford Motor Company at Highland Park, Mich. This furnace, when installed, will complete a battery of eight 2,000-lb. furnaces in the brass foundry of the company. These furnaces are expected to handle the entire brass melting requirements of the Ford organisation. The Detroit company is also installing a battery of three furnaces in the plant of the Neptune Meter Company, Long Island City, N.Y., which manufactures water meters.

Other installations now being made by the Detroit Electric Furnace Company are one 2,000-lb. furnace in the plant of the Tottenville Copper Company, Staten Island, N.Y., and one 500-lb. furnace in the United States Arsenal, Watertown, Mass. With the exception of the furnace at the Watertown Arsenal, all of the installations above mentioned are equipped with automatic electrode control, thus to eliminate the necessity of an operator in attendance at the furnace.

The British non-ferrous industry is making but slow progress with the electric furnace, due to the high cost of electricity.

The output of marine machinery for the year 1922, by Richardsons, Westgarth & Company, Limited, Hartlepool, Middlesbrough and Sunderland, aggregated 36,640 i.h.p. In addition Messrs. Richardsons, Westgarth have manufactured during the year considerable land plant with contraflo kinetic high vacuum condensing installations, including two surface condensers of 40,000 square feet each; also Nesdrum water tube boilers, steel works plant, etc.

Trade Talk.

EXTRAS on solid drawn brass and copper tubes have now been reduced by about 50 per cent.

MR. G. E. SAWYER, engineer, has removed from 35, to 41, Whittall Street, Birmingham.

THE IMPORTS of foreign iron ore at the Scnhouse Dock at Maryport last week amounted to 3,500 tons.

MR. J. M. DURIE has established himself in business as an electrical engineer at 21, Victoria Road, North Berwick.

BRUCE, PEEBLES & COMPANY, LIMITED, engineers, Edinburgh, state that their works will be closed from Friday, December 29, until Monday, January 8.

PETTIGREW & MERRIMAN, LIMITED, electrical engineers, of 122, Tooley Street, London, S.E.1, are establishing a branch at 54, Gracechurch Street, E.C.3.

THE LEWIS SPRING COMPANY, LIMITED, Redditch. have appointed Lionel Robinson & Company, 3, Staple Inn, Holborn, W.C.1, sole agents for the electrical trade for their productions.

THE Admiralty have this week placed a further contract with Joseph Kaye & Sons, Limited, of 93, High Holborn, London, W.C., and Lock Works, Leeds, for their patent seamless serrated steel oilcans.

THE LONDON ELECTRIC FIRM, of Croydon, have acquired from Henry Williams, Limited, Darlington, the branch of their business recently carried on under the style of the Arc Lamp Lowering Gear Company.

NATIONAL ALLOYS, LIMITED, Altior Works, Ilford, Essex, have appointed Mr. Robert Bell, of 73, Drury Buildings, Water Street, Liverpool, as their representative for Liverpool and the North-West of England.

THE MIDDLESBROUGH AND DISTRICT ASSOCIATION OF FOREMEN ENGINEERS AND CHIEF DRAUGHTSMEN held its annual meeting on Saturday last, when Mr. C. T. S. Arnett read an instructive paper on "Electricity as Applied to Steelworks."

THE ENTERPRISE MANUFACTURING COMPANY, LIMITED, of Electric House, Grape Street, Shaftesbury Avenue, London, W.C.2, have been appointed London and export agents for the Imperial Engineering Company, 56, Darlington Street, Wolverhampton.

W. G. BAGNALL & COMPANY, LIMITED, Stafford, have received an order for nearly a quarter of a million steel railway sleepers for the Indian Government. The firm have also in hand the construction of three locomotives for a foreign Government.

THE TWELVE MONTHS' output of new tonnage by Workman, Clark & Company, Limited, Belfast, totalled 51,095 gross tons, a reduction of 2,543 tons as compared with the previous years. The numbers of vessels launched totalled six and nine respectively.

BEFORE THE MEMBERS of the Sheffield Society of Engineers and Metallurgists, at the Applied Science Department of the University of Sheffield, on December 11, Dr. W. Rosenhain, of the National Physical Laboratory, delivered a lecture on "The Hardening of Metals."

NECOL INDUSTRIAL COLLODIONS, LIMITED, the manufacturers of Plastic wood, have, owing to the necessity for their being nearer the parent concern—Nobel Industries, Limited—at Nobel House, taken new offices at Windsor House, Victoria Street, Westminster S.W.1, to which address all letters should be sent.

THE business of Trevelyan & Company, of 155, Bracebridge Street, and C. H. Davies & Company, Limited, 153, Bracebridge Street, Birmingham, have been amalgamated, and will in future be carried on under the style of Trevelyan (Birmingham), Limited. Mr. T. Gladdy and Mr. T. Reynolds are directors of the company.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, propose to build at the Wallsend yard three vessels of about 2,500 tons each, on their own account, and suitable for service on the Canadian lakes. The company are also building a collier of about 2,600 tons d.w. capacity on speculation, besides another one which is on order for a Newcastle firm.

THE DIRECTORS of the Ropner Shipbuilding & Repairing Company. Limited, Stockton, propose to reduce the capital from £400,000 to £200,000 by returning one-half of the amount paid up on the present shares, and by exchanging shares in the reconstructed company for the remainder. There will be no change in the directorate or management.

CHINA'S NEW TARIFF SCHEDULE, which was drafted by an International Commission in session in Shanghai for six months, and is designed to fix an effective 5 per cent. *ad valorem* tariff, came into effect on December 1, with the proviso that all goods consigned to China, shipped and en route before December 1, shall be permitted to enter the country under the old tariff schedule.

THE GLASGOW TRAMWAYS COMMITTEE has approved of a recommendation to accept the tender by the Cargo Fleet Iron Company, Limited, Middlesbrough, for the supply of 4,200 tons of steel rails, with the necessary fish-plates, at an approximate cost of £41,000. An offer by a German firm, which was £5,000 lower, and one by a Belgian firm £4,000 lower were refused.

THE BIRMINGHAM METALLURGICAL SOCIETY'S annual dinner was held at the Queen's Hotel on December 16, the President (Mr. A. J. G. Smout) being in the chair. During the proceedings presentation was made of the society's silver medal to the following past-presidents: Mr. J. H. Stansbie, Professor T. Turner, Mr. I. E. Lester, Mr. F. C. A. H. Lantsberry and Mr. A. Spittle.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, of London and Darlaston, have secured contracts from Robert Heath & Low Moor, Limited, for open hearth steel plant consisting of the following:—Two open hearth steel furnaces complete with charging platforms, Wellman mechanical gas producers, 80-ton ladle crane; open hearth charging machine, magnet crane, etc.

IT IS OFFICIALLY ANNOUNCED by the Admiralty that the hull of one of the new battleships will be built on the Tyne by Sir W. G. Armstrong, Whitworth & Company, Limited. The engines and boilers are to be made on the Tyne by the Wallsend Slipway & Engineering Company, Limited. The hull and machinery of the second battleship are to be built on the Mersey by Cammell, Laird & Company. Limited. The armour for both ships will be manufactured at Sheffield, Manchester and Glasgow. The guns will be made at Newcastle-on-Tyne, Sheffield. Barrow, Manchester, Glasgow, Darlington and Woolwich. The gun mountings will be made at Barrow and Newcastle-on-Tyne.

AT A MEETING of the members of the Staffordshire Iron and Steel Institute, at the Education Offices, St. James's Road, Dudley, on December 16, Mr. Harold Harris gave an interesting paper on "Native Methods of Making Iron in India." *Inter alia*, the speaker gave an account of the processes of manufacture as carried out on the Rajdoha Copper Mining Company's property, Rajdoha, Singhblum, Chota Nagpur, Bengal, at the time of his connection with the company. together with the research work done during the past year on the actual iron made at Rajdoha. Dr. Percy, he said, in his "Metallurgy of Iron and Steel," published in 1864, gave an excellent description of the methods and furnaces employed in India, and there had been practically no alteration in the manufacture since he described it. Following the paper, which was illustrated with lantern slides, there was an interesting discussion.

Publications Received.

THE SHEEPBRIDGE COAL AND IRON COMPANY, LIMITED, CHESTERFIELD.—A well-illustrated booklet outlining their productions. It is of special interest for foundrymen, as it contains many pictures of the largest types of engineering castings.

Patent Abstracts.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, 27, Chancery Lane, W.C.2, and Commerce Chambers, Parliament Street, Nottingham.

Printed copies of the specifications in the following list will be on sale December 28, 1922.

COLELLA, F. E. Mould for casting hollow metal articles. 189,513.

FEROLITE, LIMITED, AND CLAPP, H. B. Crucibles, retorts and the like. 189,692.

BELLIS HEAT TREATING COMPANY. Crucibles. 168,887.

Societe Lorraine Miniere et Metallurgique.—This French concern reports for the financial year 1921-22 profits amounting to 535,000 fcs. (£8,230). There is to be no dividend, but the available balance is to be carried forward. The company's share capital is 50,000,000 fcs.

Schneider et Cie (Le Creusot).—This French concern reports for the year ended April 30 last, profits aggregating 11,315,423 fcs. (say, £174,100), as compared with 13,336,412 fcs. in the preceding year. A dividend of 100 fcs. per 300 fc. share is recommended, as compared with 120 fcs. (33⅓ per cent.) in the previous year. The share capital stands at 36,000,000 fcs.

IRON AND STEEL MARKETS.

Pig-iron.

Movements in the various pig-iron markets disclose few features of importance in view of the holidays now impending, business on any scale of magnitude being practically suspended until the New Year, while deliveries going forward for the next few weeks will be generally confined to requirements of an urgent character. It is, however, satisfactory to note that the outlook for the trade is far more favourable at the present time than it has been during the past twelve months, the expansion of home demand continuing progressively steady, while on the export side the total tonnage for the six months in succession records an increase. During November we exported 383,998 tons of iron and steel, including scrap. The average monthly tonnage in 1913 was 423,858 tons, so that the November figure is barely 10 per cent. down from the average for what was a record pre-war year. This is reassuring, and indicates that a definite improvement has set in. In the South Staffordshire area, quotations for all qualities of pig are firmly held, any anticipation that the reduction of rail transport charges would lead to a similar movement as regards makers' prices, having been disappointed. Already an additional 1s. is being asked for some makes of Northamptonshire forge iron, and undoubtedly there is a better demand for that quality as the output of the finished-iron works improves, while in the case of one Derbyshire firm at least forge quotations have been withdrawn. It has not yet been found possible to restart the idle furnaces in South Staffordshire and Northamptonshire, and it is not thought that the lower railway rates will be sufficent to bring them into operation again. Conditions in the Scottish industry are a little more promising, buyers recently having been taking increased interest in pig-iron, especally on forward account, some parcels for delivery early next year having been placed in the Glasgow market. With regard to foreign business 1,000 tons of Scotch iron was sold recently for the United States, whilst the inquiry from other markets is slightly better. The shipments abroad from the Clyde last week were 1,624 tons, as compared with 75 tons for the same week last year. In Lancashire, markets also disclose a firmer tendency, sellers of foundry iron making efforts to obtain little better prices, and in the case of small parcels, with some success. Competition is also in course of renewal between Northamptonshire and Derbyshire smelters, from which foundry iron consumers should gain some advantage. Business on Tees-side is just now subject to holiday influences, but the improvement in shipbuilding has encouraged some orders from makers of marine castings, who have purchased fair quantities of pig-iron for delivery over the first quarter of next year. Export trade continues to be almost negligible. In these circumstances stocks have of late tended to expand, and prices are accordingly showing a somewhat weaker tendency. No. 1 and silicious are 2s. 6d. below the peak at 95s., and No. 3 G.M.B. can be done at 91s., though prices are irregular, some makers holding out for 92s. No. 4 foundry is obtainable at about 85s., and No. 4 forge at 82s. 6d.

A brisk business is passing at Middlesbrough in hematite pig-iron. Makers are very fully sold over the next four or five weeks, and are already in a fairly satisfactonry position for the whole of the first quarter of the New Year. While the home trade has thus shown considerable improvement, export business is still on a restricted scale owing to currency difficulties. There is, also, keen competition from French sources. Prices are firmly held at last week's levels. For East Coast mixed numbers 93s. is an average figure, and the premium for the No. 1 quality varies from 6d. to 1s. per ton. Production of West Coast hematite is now hardly equal to demand, although an additional furnace has been put into blast at Barrow, while another furnace may be lighted in West Cumberland immediately, but this, it is stated, will be used for increasing the make of low-phosphorus iron, the call for which comes in the main from users in the Midlands. Prices are firm, Bessemer mixed numbers being quoted at £5 5s. to £5 10s. per ton delivered at Glasgow and Sheffield.

Finished Iron.

Though still less buoyant than other sections of the iron industry, the outlook in the finished material branch is certainly more promising in the direction of increased activity in the near future, consequent, perhaps, upon recent developments in the shipbuilding and engineering industries, both being important consuming interests in this market. The chief obstacles to progress in the finished iron trade at the moment, are, of course, the high costs of production, and the active competition of foreign makers, against which home manufacturers are almost hopelessly handicapped. The latter conditions have an adverse effect, especially as concerns makers of secondary grade iron, who are mainly subject to the Continental invasion of our markets, manufacturers of the higher qualities of marked bars owing their immunity from competition to the prestige the best-known brands enjoy in the world's markets. Consequently the firms having an established reputation in the trade are finding it a little less difficult to obtain orders, and the problem of carrying on is not so acute as it was. Current prices have not improved to any appreciable extent, and business is still insufficiently remunerative, but the experience of the last few weeks has induced a more optimistic impression. Gas strip continues quiet, owing entirely to the unfavourable comparison of its price with that for steel strip.

Steel.

The steady improvement recently reported in the steel trade continues unabated, the heavy branches of the industry, especially firms interested in railway requirements, having been largely advantaged by development schemes now being pressed forward to alleviate unemployment. The placing of war ship contracts also will undoubtedly make the improvement much more general, for business admittedly makes business. Some good orders have been placed in this country from Spain for mill work and the like, which will keep the makers busy for a considerable period. Dealing more specifically with ferro-alloys, there has been of late a fair demand for ferro-silicon and prices remain very firm, particularly for 45 per cent. grade. All makers' prices are advanced, while several makers are going out of business until prices are better. On the other hand, silico-manganese is quieter, and there is plenty offering at round about £16 10s. per ton, for 50/55 per cent. Mn., and 20/25 per cent. Si. content, while silico-spiegel with 8/10 per cent. Mn. and 10/12 per cent. Si. can be had at about £10 10s. per ton delivered, according to quantity involved. At Sheffield there is a considerable expansion in the manufacture of open-hearth steel, and production to-day is now above the average of pre-war days. A good many furnaces are still out of operation, but there is a favourable prospect of a number of these being lighted before long. Crucible steel makers are quiet, and orders are comparatively hard to obtain. The war surplus of this material continues to drug the market, high-speed steel being offered at something like a third of the price asked for new material. Until this Government surplus is disposed of it is useless to expect any revival in new business. It is also stated that German high-speed steel is on offer at low figures, but apparently there is not much of it about. In the market for semi-products business is fairly good, with dealings in billets at the increased prices active, while soft basic qualities have moved up a further five shillings. The demand for acid billets is improving, but they are not so much inquired for as basic material. The tinplate market reports a steady demand, and is firm at the latest official schedule of prices, viz., I.C. 20 x 14 x 112 sheets, 20s. per box, f.o.b. Bristol Channel ports. Some makers, however, are asking 3d. more than the minimum. The new minimum price carries with it a discount of 1 per cent. to the merchants, but the latter refuse to be content with this, and there is every possibility of a conference in the near future to discuss the matter.

Scrap.

The increased activity of demand for certain qualities of scrap iron and steel recently reported is well maintained, and markets generally indicate a more hopeful feeling, although, of course, some little time must necessarily elapse before trade can possibly return to anything like normal conditions. In the Middlesbrough market last week buying was on a more restricted scale, in view of the impending holidays, and, if anything, the price of heavy steel scrap was a shade weaker, the best figure obtainable just now being in the region of 68s. 6d. per ton, delivered works. Heavy cast-iron scrap, machinery quality, in handy pieces, has stiffened a little, and 75s. to 77s. 6d. per ton, delivered works, can be obtained this week. Good heavy steel turnings and good clean cast-iron borings are in demand, at prices in the region of 55s. per ton, delivered works. Heavy wrought-iron scrap, ordinary piling quality, can be disposed of at a price approximating 72s. 6d. per ton, delivered works, and £4 per ton can be obtained for good heavy forge iron.

IRON AND STEEL MARKETS.—*Continued.*

Metals.

Copper.—Movements in the standard copper market of late have continued very steady, fluctuations in values being confined within fairly narrow limits, seldom ranging beyond fractional proportions from day to day. A firmer undertone is, however, in evidence, influenced by more hopeful views of the position in the U.S.A., where consumption is on an expanding scale. The Continental demand generally is also on a heavier scale, and altogether the position of this metal shows good promise for the coming year. New York advices state that a large interest in the Chili Copper Company has been acquired by the Anaconda Company. Doubtless it is thought that the latter concern, in their capacity as both producers and consumers, will, to some considerable extent, be able to control prices of the metal, and this possibly accounts for a good deal of the firmness of the market across the Atlantic. Current quotations :—*Cash* : Wednesday, £62 5s. ; Thursday, £62 15s. ; Friday, £63 10s. ; Monday, £64 2s. 6d. ; Tuesday, £64. *Three months* : Wednesday, £62 17s. 6d. ; Thursday, £63 10s. ; Friday, £64 5s. ; Monday, £64 17s. 6d. : Tuesday, £64 17s. 6d.

Tin.—The position in the standard tin markets evidences a firm tendency. Consumers, however, continue to hold off, and buying is generally in disappointing volume. Almost similar conditions are noted in the States, but in this case it is surmised that operators are not too well covered, and must shortly come into the market for fair quantities of metal. Exports of tin from the Federated Malay States in November are officially stated to have amounted to 2,857 tons, as against 2,837 tons in October and 2,800 tons in the corresponding month of last year. For the first eleven months of the current year the total quantity of metal exported aggregated 32,144 tons, compared with 31,011 tons last year and 32,090 tons in 1920. Current quotations :—*Cash* : Wednesday, £176 ; Thursday, £176 15s. ; Friday, £176 15s. ; Monday, £180 5s. ; Tuesday, £180. *Three months* : Wednesday, £177 2s. 6d. ; Thursday, £177 17s. 6d. ; Friday, £177 17s. 6d. ; Monday, £181 12s. 6d. ; Tuesday, £181 10s.

Spelter.—During the past week values in the spelter market have evidenced a reaction to lower levels, and the volume of business passing has been limited in tonnage. Rudolf Wolff & Company report that consumers in this country have rather refrained from buying, though a little more inquiry is noticeable as the week closes. Reports from America point to renewed firmness there, and similar conditions obtain on the Continent, where seemingly no stock of metal exists. Current quotations :—*Ordinary* : Wednesday, nominal ; Thursday, nominal ; Friday, nominal ; Monday, nominal ; Tuesday, £38 10s.

Lead.—The business passing in soft foreign pig is quiet and steady, with prices subject to very few fluctuations of importance. Consumptive demand continues in fair volume at home, but Continental buying is disappointing in volume. Current quotations :—*Soft foreign (prompt)* : Wednesday, £26 2s. 6d. ; Thursday, £26 2s. 6d. ; Friday, £26 2s. 6d. ; Monday, £26 ; Tuesday, £25 12s. 6d.

Deaths.

Mr. W. Sloan, of Elmwood Villa, Bramley, died on December 16 after a brief illness. Mr. Sloan, who was 73 years of age, was one of the founders of the firm of Sloan and Davidson, Limited, ironfounders, Stanningley. He went to Leeds from Scotland about 35 years ago, and shortly afterwards commenced business, in partnership with Mr. William Davidson, at the Carrick Foundry, Kirkstall Road. Some years ago the firm removed to Stanningley.

Colonel John M'Ausland Denny, C.B., D.L., chairman of the firm of William Denny & Brothers, Limited, shipbuilders and engineers, Dumbarton, died on December 16 in a nursing home in Glasgow. Colonel Denny, who was in his 65th year, was widely known in shipbuilding, engineering and shipping circles all over the United Kingdom. His father was the late Peter Denny, LL.D., founder of the world-famous firm now known as William Denny & Brothers, Limited, a firm which had contributed in a very remarkable degree to the prosperity and development of the burgh in which its works are situated.

Acieries de Sambre-et-Meuse.—This French concern reports for the financial year ending June 30, a surplus of 6,395,926 fcs. (say, £100,000 at current rate), and is to distribute a dividend and super dividend aggregating 250 fcs. net per share (50 per cent.). The amount carried forward is equal to over 6 per cent. on the share capital which stands at 4,000,000 fcs.

Company News.

Dollis Engineering Company, Limited.—Capital £1,500 in £1 shares. Directors: C. G. H. Adam and A. H. Harrison.

Broughton Copper Company, Limited.—Interim dividend, 5 per cent., less tax, on both ordinary and preferred shares.

Harry N. Booker, Limited, Wellington Garage, Foundry Street, Barnsley.—Capital £5,000 in £1 shares. Engineers.

Atlas Steel Foundry Company, Limited.—Loss, £13,791; surplus brought forward converted into adverse balance of £9,798.

Fosse Foundry Company, Limited, Ivy Cottage, The Fosse, Syston, Leicester.—Capital £1,000. Directors: C. R. Carter and W. Hunt.

J. H. Carruthers & Company, Limited, Polmadie, Glasgow.—Capital £33,000 in £1 shares. Engineers. Directors: J. Gourlay and M. Jackson.

Adams Non-Ferrous Metal Company, Limited, 71, Legge Street, Birmingham.—Capital £3,000. Permanent managing director: H. F. Adams.

Hills' Dry Dock & Engineering Company, Limited.—Loss, £807; credit balance brought in, £18,008; carry forward, £17,201; ordinary dividend passed.

A. J. Jackson, Limited.—Capital £5,000 in £1 shares (4,000 preference and 1,000 ordinary). Engineers. Directors: J. H. Woodington, A. J. Jackson, and A. H. Miles.

Hertford Engineering Company, Limited, 3, Blenheim Street, London, W.—Capital £12,000. Permanent directors : J. T. Sanders (chairman), R. Forster, E. C. Maylin, R. W. Richards and J. Wing.

North Lonsdale Iron and Steel Company, Limited.—Depreciation, £2,000; credit balance, £12,460; brought forward, £17,654; total, £30,114; dividend, 5 per cent., less tax; carry forward, £17,773.

Kent Construction & Engineering Company, Limited, 79, Mark Lane, London, E.C.—Capital £30,000. Directors: T. Haig, T. H. Board, W. R. Honeywell (managing director), F. Wakeman and D. A. Dwyer.

Armstrong Whitworth Development Company, Limited.—Dividend, 6 per cent. per annum, less tax, on preference for half-year, making 6 per cent. ; carry forward, £16,675; ordinary dividend, 12½ per cent., free of tax.

Metalcraft, Limited, 6, Windmill Street, London, W.1.—Capital £2,000 in £1 shares (1,000 preference and 1,000 ordinary). Brass finishers, bronzers, etc. Directors: H. Jones (managing director), C. E. Overton and F. Yoxall.

Lloyd & Rider, Limited, Nile Street, Birmingham. —Capital £12,000 in £1 shares (4,600 preferred ordinary), to adopt an agreement with D. C. Lloyd, and to carry on the business of brassfounders, metal stampers and piercers, etc.

Personal.

Viscount Long, ex-First Lord of the Admiralty, has joined the new board of directors of Henry Bessemer & Company, Limited.

The late Mr. W. J. Llewellyn, of Park Road, Redditch, retired engineer, left gross estate of the value of £10,928, with net personalty £9,916.

Mr. Richard Smith, of Drigg, Cumberland, has been elected chairman of the Cumberland Iron Ore Proprietors' Mutual Indemnity Society, in succession to the late Mr. W. E. Walker, of Woodend. Mr. Smith is a member of the Advisory Committee of the Cumberland Conciliation Board (Iron Industries), and is also manager of Ainsworths Margaret Mine, and of Stirlings iron mines in Cumberland.

Gazette.

Messrs. J. Reed, F. Parr and W. E. Glover, engineers, 205, Jack Lane, Hunslet, Leeds (trading under the style of Reed & Glover), have dissolved partnership. Mr. J. Reed Continues.

The partnership heretofore subsisting between Messrs. S. G. Railton and S. J. Aldcroft, engineers and ironfounders, 53A, Seel Street, Liverpool, under the style of Railton & Aldcroft, has been dissolved.

At the expiration of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies and the companies will be dissolved : Agricultural Implements Manufacturing and Supply Company, Limited ; Barron Expanding Ferrule Company, Limited ; Elliott Jones Vertical Coke Oven Syndicate, Limited.

The . . .

STAVELEY COAL & IRON CO.,

LIMITED.

Works and Head Office:

STAVELEY WORKS near CHESTERFIELD.

Telegraphic Address: "STAVIRON, BARROWHILL." *Telephone: 251 CHESTERFIELD (Pvte. Bnch. Ex.)*

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34, Victoria Street, S.W.1.
Telegraphic Address: "STAVIRONCO, VIC."
Telephone: 4639 VICTORIA.

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Telegraphic Address: "STAVIRON, MANCHESTER."
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Pig-Iron Manufacturers.

Suitable for all

GENERAL FOUNDRY PURPOSES.

Brands: STAVELEY and RINGWOOD.

The Services of our expert Metallurgical Staff are at Buyers' disposal.
We are prepared to advise suitable mixtures, for all foundry purposes.

CAST IRON PIPES

of all sizes for Water, Gas, Steam and Hydraulic Pressure.

HEAVY CASTINGS OF ALL DESCRIPTIONS.

Chemical Manufacturers:

Aniline Oil,
Aniline Salt,
Naphthaline Balls,
Naphthaline Tablets,
Hot Pressed Naphthalene,
Naphthalene Flakes,
Naphthalene Powder,
Cresylic Acid,
Crude Carbolic Acid,
Creosote Oil,
Green Oil, Pitch,
Sulphate of Ammonia,
Muriate of Ammonia,
B.O.V. & R.O.V.,
Oleum (all strengths),
Pure Sulphuric Acid,
Nitric Acid,
Disinfectant Powder.

'STAVEHO" For Making Cement Work Waterproof.

PLEASE WRITE FOR PRICES.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	18	9
Three months	63	7	6
Electrolytic	70	5	0
Tough	66	5	0
Best selected	66	10	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	15	0
Do. Aug.	71	12	6
Do. Sept.	71	12	6
Ingot bars	71	10	0
H.C. wire rods	75	15	0
Off. aver. cash, June	62	0	11¼
Do. 3 mths., June	62	8	5¼
Do. Settlement June	62	1	0⅞
Do. Electro, June	70	1	2⅞
Do. B.S., June	67	12	2⅞
Aver. spot price, copper, June	61	19	11¼
Do. Electro, June	70	15	8½

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9¼d

BRASS.

Solid drawn tubes .. 11¼d.
Brazed tubes 13d
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 9¾d.
Wire .. .. .. 9¼d.
Rolled metal .. 9¼d.

TIN.

Standard cash	153	10	0
Three Months	154	5	0
English	153	10	0
Bars	155	10	0
Chinese	152	0	0
Straits	155	0	0
Australian	156	10	0
Eastern	157	10	0
Banca	153	10	0
Off. aver., cash, June	152	12	3⅛
Do. 3 mths., June	153	14	5¾
Do. Sttlment. June	152	12	3⅛
Aver. spot, June	152	11	1

SPELTER.

Ordinary	28	7	6
Remelted	25	15	0
Hard	20	0	0
Electro 99.9	32	15	0
English	28	15	0
India	22	5	0
Prime Western	28	10	0
Zinc dust	40	0	0
Zinc ashes	4	15	0
Off. aver., June	27	16	1¾
Aver., spot, June	27	17	11¾

LEAD.

Soft foreign ppt	25	5	0
English	25	15	0
Off. average, June	24	3	2¾
Average spot, June	24	14	2

ZINC SHEETS.

Zinc sheets, English	36	0	0
Do. V.M. ex. whf.	36	0	0
Rods	41	0	0
Dutch	36	0	0
Boiler plates	34	0	0
Battery plates	34	10	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	24	10	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 10 0 to 12 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 13 2 6
75% 23 5 0

Ferro-vanadium—
35/40% 18/3 to 18/6 lb. va.

Ferro-molybdenum—
70/75% 6/- to 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23 5

Ferro-chrome—
Max. 2% car. .. £68
Max. 1% car. .. £78
Max. 0.70% car. .. £94
67/70%, carbonless 1/9½ lb.

Nickel—99%, cubes or pellets £160

Cobalt metal—98/99% 10/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb

Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	2	18	0	3	8	6
Mixed iron & steel	2	17	6	3	5	0
Heavy cast iron	3	10	0	4	0	0
Good machinery for foundries		4	0	0		

Cleveland—			
Heavy steel	3	0	0
Steel turnings	2	5	0
Cast-iron borings	2	5	0
Heavy forge	3	7	6
Bushelled scrap	3	0	0
Cast-iron scrap	3	15	0

Lancashire—			
Cast iron scrap	4	5	0
Heavy wrought	3	5	0
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	54	10	0
Brass (clean)	29	0	0
Lead (less usual draft)	20	10	0
Tea lead	18	10	0
Zinc	16	0	0
New aluminium cuttings	65	0	0
Braziery copper	44	10	0
Gun metal	39	0	0
Hollow pewter	120	0	0
Shaped black pewter	70	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	90/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	95/-
Hematite M/Nos.	94/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/-
,, No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	107/6
W.C. hematite	115/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (crown)	£10 10 to £12		
Angles	£11 to £12	10	0
Tees to 3 united ins.	£11 10 to 13	0	0
Nut and bolt	10	0	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	7	6
Bolts and nuts, ¾ in. × 4 in.	22	0	0

Steel—			
Ship plates	10	0	0
Boiler plates	13	10	0
Chequer plates	10	10	0
Angles	9	10	0
Tees	10	10	0
Channels	8	15	0
Joists	10	0	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1¼in.	8	10	0

	£	s.	d.
Rails, heavy	9	10	
Fishplates	14	10	
Hoops	12	0	
Black sheets, 24 g.	12	0	
Galv. cor. sheets, 24 g.	15	15	
Galv. fencing wire, 8 g. plain	16	0	
Rivets, ½ in. dia	15	0	
Billets, soft	7 5 0 to 7 10		
Billets, hard	8	0	
Sheet bars	7 7 6 to 7 15		

PHOSPHOR BRONZE.

	Per l basis
Strip	1 3
Sheet	1 3
Wire	1 3
Rods	1 2
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £4 above price of B.S.
15% phosphor copper, £5 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SONS LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES

	Per lb.
Ingots for raising	11d. to 1/6
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11
To 15 in. wide	1/6½ to 2/0
To 18 in. wide	1/7½ to 2/1
To 21 in. wide	1/8½ to 2/2
To 25 in. wide	1/9½ to 2/3
Ingots for spoons and forks	11d. to 1/8
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3

with extras according to gauge

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.

	Dol
No. 2X foundry, Phila.	27.5
No. 2 foundry Valley	24.0
No. 2 foundry, Birm.	18.0
Basic	26.0
Bessemer	26.0
Malleable	26.0
Grey forge	25.0
Ferro-manganese 80 % delivered	70.5
Bess. rails, h'y, at mill	40.0
O.-h. rails, h'y, at mill	40.0
Bess. billets	35.0
O.-h. billets	35.0
O.-h. sheet bars	35.0
Wire rods	40.0
	Cent
Iron bars, Phila.	1.9
Steel bars	1.7
Tank plates	1.7
Beams, etc.	1.7
Skelp, grooved steel	1.7
Skelp, sheared steel	1.7
Steel hoops	2.4
Sheets, black, No. 28	3.1
Sheets, galv., No. 28	4.1
Sheets, blue an'l'd, 9&10	2.4
Wire nails	2.4
Plain wire	2.2
Barbed wire, galv.	3.0
Tinplate, 100-lb. box	$4.7

COKE (at ovens)

Welsh foundry	32
,, furnace	22
Durham & North. foundry	28
,, furnace	23
Other Districts, foundry	27
,, furnace	22

SWEDISH IRON.

	£ s. d.
Bars, hammered basis sizes Basis price	£24 to £25
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Rail Rods— Square, round and flats ..	
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents here.

TUBES.

Up to and incl. 6 in.

Gas	.. 55%	Tube prices are now free.
Water	.. 50%	
Steam	.. 45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/9
,,	28×20, ,,	39/6
,,	20×10, ,,	28/3
,,	18¾×14, ,,	20/-
I.X.	,	45/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝ ,,	37/6
C.V.B.G.	16¾×15, ,,	34/9
I.C.W.	20×14, ,,	17/9
,,	28×20, ,,	36/-
,,	20×10, ,,	24/9
,,	18¾×14, ,,	18/3
Terneplates,	28×20. ,,	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
July 5	62	10	0	No change
,, 6	62	7	6	dec. 2 6
,, 7	62	18	9	inc. 11 3
,, 10	62	17	6	dec. 1 3
,, 11	62	18	9	inc. 1 3

Electrolytic Copper.

July 5	70	0	0	No change
,, 6	70	0	0	,,
,, 7	70	0	0	,,
,, 10	70	5	0	inc. 5/-
,, 11	70	5	0	No change

Standard Tin (cash).

July 5	153	10	0	dec. 7 6
,, 6	153	17	6	inc. 7 6
,, 7	154	5	0	,, 7/6
,, 10	154	10	0	,, 5/-
,, 11	153	10	0	dec. 20/-

Tin (English ingots)

July 5	153	10	0	dec. 20/-
,, 6	154	0	0	inc. 10/-
,, 7	154	0	0	No chang
,, 10	154	10	0	inc. 10/-
,, 11	153	10	0	dec. 20/

Zinc Sheets (English)

July 5	36	0	0	No change
,, 6	36	0	0	,,
,, 7	36	0	0	,,
,, 10	36	0	0	,,
,, 11	36	0	0	,,

Spelter (ordinary).

July 5	28	2	6	inc. 2/6
,, 6	28	2	6	No change
,, 7	28	2	6	,,
,, 10	28	5	0	inc. 2/6
,, 11	28	7	6	,, 2/6

Lead (English)

July 5	25	15	0	No change
,, 6	25	15	0	,,
,, 7	25	15	0	,,
,, 10	25	15	0	,,
,, 11	25	15	0	,,

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

WM OLSEN
LIMITED,
Cogan Street and
1-3-5-7 Spruce Street, **HULL,**
— FOR —
FOUNDRY SUPPLIES
Price Lists on Application.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.
REGISTERED TRADE MARK
1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.
WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

COREMAKER, Age 30, seeks supervisory position. Fully experienced in small and intricate General Engineering Work and Repetition Work on Machines. References if required, Box No. 218, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MOULDER, 38, would like a change, home or abroad, as FOREMAN, or in charge of apprentices. Experienced in Engineering, Railway Work, Locomotive, Moulding Machines, etc.—Apply to Box 220, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER or FOREMAN (38), disengaged, wants post; technical training; 23 years' experience grey iron and non-ferrous metals; general engineering and high-class light castings; greensand, drysand, loam, plate and machine; piece rate fixing; efficient cupola practice; good organiser; good references.—Box 216, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, a thoroughly experienced FOREMAN, to take entire charge of small Malleable Iron Foundry; must have had first-hand experience of Moulding, both machine and hand, core making and annealing with Dowson & Mason Gas Furnace. Able to control men and output on economical lines. Apply, stating age, experience and salary required, to Box, 208, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, working charge hand for small Iron Foundry. Must be thoroughly conversant with machine—produced light-grey iron castings. State experience, and salary required.—Box 210, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATENTS.

THE PROPRIETOR OF THE PATENT No. 22,792 of 1910, for "Method of bessemerizing copper matte" is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents, 28 Southampton Buildings, Chancery Lane, London, W.C.2.

MACHINERY.

FOR SALE.

Ingersoll Sergeant Direct Line Steam-Driven Air Compressor, 14½ in. air cyl., 14 in. steam, 14 in. stroke, capacity 384 cubic ft. free air per minute. Horizontal Engine, trunk slide pattern, 18 in. cyl., 36 in. stroke, by E. R. and F. Turner. Two Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20 in. cyls., 26 in. stroke, by Robey & Co., Ltd. 75 K.W. Generating Set, Compound "Bellis" Engine direct coupled to Mather & Platt Generator, 460 volts, 163 amps., 440 revs. No. 9 Pulsometer Pump, 7 in. suction, with foot valve and strainer. Vertical Three-Throw Geared and Belt-Driven Hydraulic Pumps, rams 2½ in. diam., 6 in. stroke, by H. Berry & Co., Ltd. Single Standard Hydraulic Forging Press, 10 in. ram, about 14 in. stroke, working pressure 1,500 lbs., by H. Berry & Co., Ltd. Two Horizontal Hydraulic Breaking Presses, ram 12 in. diam., 6 in. stroke, working pressure 1 ton per sq. in., by H. Berry & Co., Ltd. Horizontal Boring Machine, by Noble & Lund, hole in spindle 3 in., T slotted table 3 ft. 6 in. x 3 ft. 6 in., bed 7 ft. 6 in. long. 36 in. Colburn Vertical Boring and Turning Mill, with 30 in. chuck-plate.

Catalogue of Stock Machinery, 5-6,000 Lots Free on Application. Inspection Invited

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

MACHINERY (*continued*).

FOR SALE—SPECIAL.

Eight very good second-hand Single-ended, Four-furnace MARINE BOILERS, 10 ft. 2 in. diam. by 16 ft. 3 in. long, with all steam and furnace fittings, re-insureable at a working pressure of 145 lbs. per sq. inch. For details, price and copy of Insurance Co.'s report, apply—

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

ONE new 2-ton Geared Ladle for sale; price £20.—For further particulars apply to TURNER, ATHERTON & COMPANY, LIMITED, Denton.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

MACHINERY FOR SALE.

4 FT. brand new Foundry Sand Mixer, two Steel Tubes, 6 ft. x 3 ft. diameter, make excellent Cupola. Sirocco 8-in. Belt Driven Fan, 7½-h.p. Campbell Oil Engine, small Planing Machine by Kershaw, 30-h.p. Hornsby Gas Engine, practically new. Low prices.

HARRY H. GARDAM & COMPANY, LIMITED,
STAINES.

MISCELLANEOUS.

SOMETHING NEW.—To Safe and Strong-Room Door Manufacturers. A Material that will resist burning by Oxy-Acetylene and Electricity. All interested can test same conditionally on expenses being defrayed. All correspondence dealt with in strict rotation. Correspondence only in first instance, to F. P., c/o 462, Commercial Road, Portsmouth, Hants.

A FULLY-EQUIPPED IRON FOUNDRY, with good connection, capable of turning out 15 to 20 tons per week. To be let or sold. For further particulars, write Box 214, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

GROUND GANISTER, Fire Clay, Clean Sharp Sand for Furnace Bottoms, Astbury Silica Company (Established 30 years).—Write, D. BOULTON, Kidsgrove, Stoke-on-Trent.

ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to fifteen cwt. Complete machines built throughout to specification, singly or in quantity. Designing and patterns a speciality.—C. S. PEATFIELD, LIMITED, Market Rasen.

TO IRON, STEEL, NON-FERROUS FOUNDRIES AND MANUFACTURERS.

Expert metallurgical, analytical and consulting service given by old-established firm of metallurgical chemists (chemical analysis, general foundry work, mixtures, research, etc.). Write at once for lists and details.—BEECROFT & PARTNERS, LIMITED, Valley Road, Chesterfield.

WANTED TO PURCHASE.

FOUNDRY Plant and machinery of all kinds, for resale. Prompt cash paid, or I will supply suitable machines for your work, taking your idle plant in part payment.

A LARGE STOCK of Foundry Plant, also loose tools, may always be seen at my works here.

ENQUIRIES for Foundry Plant, either new or second-hand receive my prompt attention.

ALEX. HAMMOND,

FOUNDRY MACHINERY MERCHANT,

"BOXTED"—SLOUGH—BUCKS.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

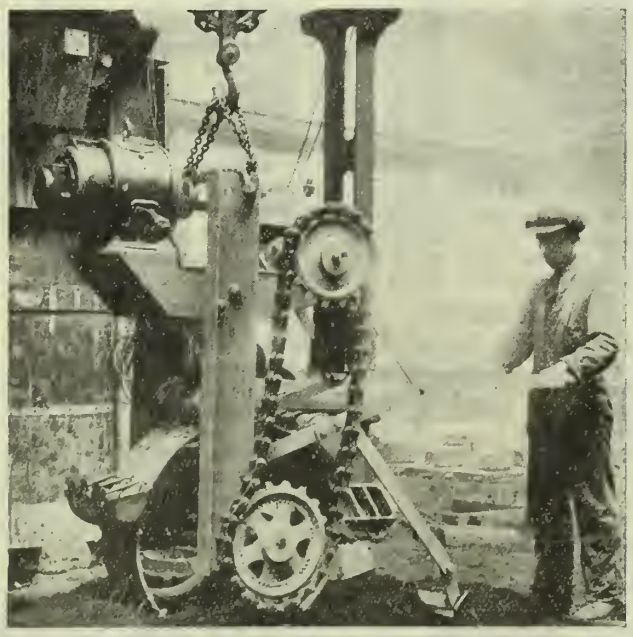
TWO NEW Labour Savers FOR THE FOUNDRY

1. FOUNDRY FLOOR DRESSER.
Turns over and mixes the sand, operated by crane man and one labourer.

2. NEW LOAM CORE-MAKING MACHINE.
Straight cores on barrels run up by **one** man in less time, and truer cores produced.

On View at Foundry Exhibition, Birmingham, June, 1922.

PATENTS APPLIED FOR.



MAKERS

RITCHIE, HART & Co., Ltd.,

Engineers BELFAST.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	2	6
Three months	63	8	9
Electrolytic	70	10	0
Tough	66	5	0
Best selected	66	5	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	17	6
Do. Aug.	71	17	6
Do. Sept.	—		
Ingot bars	71	17	6
H.C. wire rods	76	10	0
Off. aver. cash, June	62	0	11¼
Do. 3 mths., June	62	8	5¼
Do. Settlement June	62	1	0¾
Do. Electro, June	70	1	2¾
Do. B.S., June	67	12	2¾
Aver. spot price, copper, June	61	19	11¼
Do. Electro, June	70	15	8½

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes 13d
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 9¾d.
Wire .. .. .. 9½d.
Rolled metal .. 9½d.

TIN.

Standard cash	155	2	6
Three Months	155	12	6
English	155	0	0
Bars	157	0	0
Chinese	153	2	6
Straits	156	10	0
Australian	157	0	0
Eastern	156	15	0
Banca	155	2	6
Off. aver., cash, June	152	12	3¼
Do. 3 mths., June	153	14	5¾
Do. Sttlment. June	152	12	3¼
Aver. spot, June	152	11	1

SPELTER.

Ordinary	29	5	0
Remelted	26	0	0
Hard	20	10	0
Electro 99.9	33	5	0
English	29	7	6
India	22	10	0
Prime Western	29	5	0
Zinc dust	40	0	0
Zinc ashes	4	15	0
Off. aver., June	27	16	1¾
Aver., spot, June	27	17	11¾

LEAD.

Soft foreign ppt	25	5	0
English	26	5	0
Off. average, June	24	3	2¼
Average spot, June	24	14	2

ZINC SHEETS.

Zinc sheets, English	36	0	0
Do. V.M. ex. whf.	36	0	0
Dutch	36	0	0
Rods	41	0	0
Boiler plates	34	0	0
Battery plates	34	10	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	24	10	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 10 0 to 12 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
45/50%	13	2	6
75%	23	0	0

Ferro-vanadium— 35/40% 18/3 lb. va.
Ferro-molybdenum— 70/75% 6/6 lb. mo.
Ferro-titanium— 23/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £20
Ferro-tungsten— 80/85%, carbon free 1/5 lb.
Tungsten metal powder— 98/99% .. .. 1/8 lb.
Ferro-chrome— 4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23 5
Ferro-chrome— Max. 2% car. .. £68
Max. 1% car. .. £78
Max. 0.70% car. .. £94
67/70%, carbonless 1/9½ lb.
Nickel—99%, cubes or pellets £160
Cobalt metal—98/99% 10/6 lb.
Aluminium—98/99% £100
Metallic Chromium— 96/98% .. .. 5/- lb
Ferro-manganese (net)— 76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese— 94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	2	18	0	3	10	0
Mixed iron & steel	2	17	6	3	7	6
Heavy cast iron	3	10	0	4	0	0
Good machinery for foundries				4	0	0
Cleveland—						
Heavy steel				3	0	0
Steel turnings				2	5	0
Cast-iron borings				2	5	0
Heavy forge				3	10	0
Bushelled scrap				3	2	6
Cast-iron scrap				3	19	0
Lancashire—						
Cast iron scrap				4	2	6
Heavy wrought				3	5	0
Steel turnings				2	2	6

London—	£	s.	d.
Copper (clean)	54	10	0
Brass (clean)	29	0	0
Lead (less usual draft)	20	10	0
Tea lead	18	10	0
Zinc	16	0	0
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Hollow pewter	120	0	0
Shaped black pewter	70	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	90/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	95/-
Hematite M/Nos.	94/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge 70/- to	72/6
„ foundry No. 3 77/6 „	80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	100/-
„ No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	107/6
W.C. hematite	115/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (crown)	£10	10	to	£12	0	
Angles	£11	to	£12	10	0	
Tees to 3 united ins.	£11	10	to	13	0	0
Nut and bolt				10	0	0
Hoops				14	0	0
Marked bars (Staffs.)				13	10	0
Gas strip				11	7	6
Bolts and nuts, ¾ in. × 4 in.				20	10	0
Steel—						
Ship plates				10	0	0
Boiler plates				13	10	0
Chequer plates				10	10	0
Angles				9	10	0
Tees				10	10	0
Channels				8	15	0
Joists				10	0	0
Rounds & squares 3-in. to 5½in.				10	10	0
Rounds, under 3in. to ⅜in.				9	10	0
Flats, over 5in. wide and up				10	0	0
Flats 5in. to 1¼in.				8	10	0

	£	s.	d.
Rails, heavy	9	10	
Fishplates	14	10	
Hoops	12	0	
Black sheets, 24 g.	12	0	
Galv. cor. sheets, 24 g.	15	15	
Galv. fencing wire, 8 g. plain	16	0	
Rivets, ¾ in. dia	14	0	
Billets, soft	7 5 0 to	7	10
Billets, hard	8	0	
Sheet bars	7 7 6 to	7	10

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 3
Sheet	1 3
Wire	1 3
Rods	1 2
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £4(above price of B.S.
15% phosphor copper, £5(above price of B.S.
Phosphor tin (5%), £30 abov price of English ingots.

CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6½ to 2/0½
To 18 in. wide	1/7½ to 2/1½
To 21 in. wide	1/8½ to 2/2
To 25 in. wide	1/9½ to 2/3
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3

with extras according to gauge

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dolla
No. 2X foundry, Phila.	27.6
No. 2 foundry Valley	24.0
No. 2 foundry, Birm.	18.50
Basic	26.9
Bessemer	26.7
Malleable	26.4
Grey forge	25.2
Ferro-manganese 80 % delivered	70.8
Bess. rails, h'y, at mill	40.0
O.-h. rails, h'y, at mill	40.0
Bess. billets	35.0
O.-h. billets	35.0
O.-h. sheet bars	35.0
Wire rods	40.0
	Cents
Iron bars, Phila.	1.92
Steel bars	1.7
Tank plates	1.7
Beams, etc.	1.7
Skelp, grooved steel	1.7
Skelp, sheared steel	1.7
Steel hoops	2.5
Sheets, black, No. 28	3.1
Sheets, galv., No. 28	4.1
Sheets, blue an'l'd, 9&10	2.4
Wire nails	2.4
Plain wire	2.2
Barbed wire, galv.	3.0
Tinplate, 100-lb. box	$4.7

COKE (at ovens).

Welsh foundry	32/(
„ furnace	22/(
Durham & North. foundry	28/-
„ furnace	23/(
Other Districts, foundry	27/(
„ furnace	22/(

SWEDISH IRON.

ars, hammered basis sizes Basis price £22 to £23

olled Ordinary— Assortment .. £ 17 s. 0 d. 0 to

ail Rods— Square, round and flats .. 17 10 0

eg Steel nom. £38 to £40

aggot Steel nom. £30 to £32

looms—

Single welded .. £10 to £11

illets—

Single and double welded £13 to £14

ig-Iron—

Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

		Up to and incl. 6 in.	
Gas	..	55%	Tube prices are now free.
Water	..	50%	
Steam	..	45%	

TINPLATES.

I.C.Cokes, 20×14, box		19/9
,, 28×20, ,,		39/6
,, 20×10, ,,		28/3
,, 18¾×14, ,,		20/-
I.X.	,	45/-
I.X.X.	,,	51/-
F.C.B.Y. 21×13⅝	,,	37/6
C.V.B.G. 16½×15,	,,	34/9
I.C.W. 20×14,	,,	17/9
,, 28×20,	,,	36/-
,, 20×10,	,,	24/9
,, 18¾×14,	,,	18/3
Terneplates, 28×20,	,,	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
July 12	63	3	9	inc.	5/-
,, 13	63	5	0	,,	1/3
,, 14	63	0	0	dec.	5/-
,, 17	63	1	3	inc.	1/3
,, 18	63	2	6	inc.	1/3

Electrolytic Copper.

July 12	70	5	0	No change
,, 13	70	5	0	,,
,, 14	70	5	0	,,
,, 17	70	10	0	inc. 5/-
,, 18	70	10	0	No change

Standard Tin (cash).

July 12	153	7	6	dec.	2/6
,, 13	153	2	6	,,	5/-
,, 14	153	5	0	inc.	2/6
,, 17	153	12	6	,,	7/6
,, 18	155	2	6	,,	30/-

Tin (English ingots)

July 12	153	10	0	No change
,, 13	153	0	0	dec. 10/-
,, 14	153	5	0	inc. 5/-
,, 17	153	15	0	,, 10/-
,, 18	155	0	0	,, 25/-

Zinc Sheets (English).

July 12	36	0	0	No change
,, 13	36	0	0	,,
,, 14	36	0	0	,,
,, 17	36	0	0	,,
,, 18	36	0	0	,,

Spelter (ordinary).

July 12	28	5	0	dec.	2/6
,, 13	28	10	0	inc.	5/-
,, 14	28	17	6	,,	7/6
,, 17	29	0	0	,,	2/6
,, 18	29	5	0	,,	5/-

Lead (English).

July 12	25	15	0	No change
,, 13	26	0	0	inc. 5/-
,, 14	26	0	0	No change
,, 17	26	5	0	inc. 5/-
,, 18	26	5	0	No change

WM OLSEN LIMITED,

Cogan Street and 1-3-5-7 Spruce Street, HULL,

— FOR —

FOUNDRY SUPPLIES

Price Lists on Application.

SHROPSHIRE IRON Co., Ltd.

Works :— Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams :— Sun, Wellington, Salop. Sunbrand (Cannon), London.

Telephone :— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE

in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire

To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER or FOREMAN (38), disengaged, wants post; technical training; 23 years' experience grey iron and non-ferrous metals; general engineering and high-class light castings; greensand, drysand, loam, plate and machine; piece rate fixing; efficient cupola practice; good organiser; good references.—Box 216, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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PARTNERSHIP: Good opportunity for energetic man, with small capital, as junior partner in old-established patternmaking business.—Apply, Box 222, Office of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

METALLURGIST AND FOUNDRY MANAGER (28), who has just relinquished control of a Foundry, desires permanent, progressive post. Green, dry and loam moulding, electric, Siemens, Bessemer and crucible melting; University metallurgical degree course, M.I.M and M.I.S.I.—Box 224, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATENTS.

THE PROPRIETOR OF THE PATENT No. 22,792 of 1910, for "Method of bessemerizing copper matte" is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents, 28 Southampton Buildings, Chancery Lane, London, W.C.2.

ENDLESS STEEL BELTS.—The Owner of British Patent No. 147667, which relates to the manufacture of Endless Steel Belts by Rolling from Seamless Tubing, is desirous of entering into negotiations for the granting of licences thereunder on reasonable terms.—Communications please address to DICKER & POLLAK, 20-23, Holborn, London, E.C.1.

MACHINERY.

FOR SALE.

Three Lancashire Boilers, 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Two Cornish Boilers, 28 ft. x 6 ft. diameter, reinsure 90 lbs. pressure. Two Marine Boilers, 10 ft. 4 in. x 12 ft. 2 in. diameter, reinsure 150 lbs. pressure. One Vertical Cross Tube Boiler, about 12 ft. high x 6 ft. diameter, reinsureable 90 lbs. working pressure. One Vertical Boiler, 6 ft. 6 in. x 3 ft. 9 in. diameter, reinsure 80 lbs. pressure. Eight good Second-hand Single-ended, Three-furnace Marine Boilers, 10 ft. 2 in. long x 16 ft. 3 in. diameter, Foxe's Patent Furnaces, reinsureable at 145 lbs. per sq. in. working pressure. "Galloway" Boiler, 24 ft. x 6 ft. 3 in. diameter, reinsure 100 lbs. pressure.

Catalogue of Stock Machinery, 5-6,000 Lots Free on Application. Inspection Invited

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

MACHINERY (*continued*).

MACHINERY FOR SALE.

4 FT. brand new Foundry Sand Mixer, two Steel Tubes, 6 ft. x 3 ft. diameter, make excellent Cupola. Sirocco 8-in. Belt Driven Fan, 7½ h.p. Campbell Oil Engine, small Planing Machine by Kershaw, 30-h.p. Hornsby Gas Engine, practically new. Low prices.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

FOR SALE—SPECIAL.

Eight very good second-hand Single-ended, Four-furnace MARINE BOILERS, 10 ft. 2 in. diam. by 16 ft. 3 in. long, with all steam and furnace fittings, reinsureable at a working pressure of 145 lbs. per sq. inch. For details, price and copy of Insurance Co.'s report, apply—

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

ONE new 2-ton Geared Ladle for sale; price £20.—For further particulars apply to TURNER, ATHERTON & COMPANY, LIMITED, Denton.

"BREAKIR" Improved Foundry Sand Disintegrators and Mixers (capacities from one to ten tons per hour), obtain many improvements. Write for leaflets and quotations to the makers, W. BREALEY & COMPANY, LIMITED, Russell Street, Sheffield, or their Agents.

MISCELLANEOUS.

NORTHAMPTON IRON ORE.—For sale, by order of Mortgagees, Farm containing 238 acres, valuable bed of Ironstone believed to exist thereunder, land adjoining worked. Above Farm key position to railway and adjoining land. Price freehold (cheap). £12,000.—Apply to MESSRS. MERRY & SON, Auctioneers, Northampton.

GROUND GANISTER, Fire Clay, Clean Sharp Sand for Furnace Bottoms, Astbury Silica Company (Established 30 years).—Write, D. BOULTON, Kidsgrove, Stoke-on-Trent.

FOR SALE.

MOULDING Machines, 3 Darling and Sellars' turnover machines, 4 Tarbor pneumatic squeezers, 2 Evans duplex power squeezers, 2 Evans hand squeevers.

MOULDING Boxes, A large selection IN STOCK, send for list.

SAND Plant, New rotary Sifters £18 each, New mixers 48 in. casing £30 each, Two 4 ft. sandmills secondhand £22 each, One 6 ft. sandmill secondhand £60.

FOUNDRY Tools, Weights, shanks, clamps, crucible stands, rumblers, fans and blowers. ALL KINDS of foundry plant IN STOCK HERE.

ALEX. HAMMOND,

FOUNDRY MACHINERY MERCHANT.

"BOXTED"—SLOUGH—BUCKS.

Ground Ganister

FOR EVERY TYPE OF FURNACE.

Steel Moulders' Composition.

SUITABLE FOR ALL WEIGHTS AND DESCRIPTIONS OF STEEL CASTINGS.

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MANUFACTURERS OF HIGH-CLASS REFRACTORY GOODS.

Telegrams: "Longdenson, Sheffield." Telephone No. 4577 (2 lines).

SWEDISH IRON.

	£ s. d.
Bars, hammered basis sizes Basis price £22 to £23	
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/9
,,	28×20, ,,	39/3
,,	20×10, ,,	27/6
,,	18¾×14, ,,	19/9
I.X.	,	45/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝ ,,	37/3
C.V.B.G.	16½×15, ,,	35/
I.C.W.	20×14, ,,	17/11½
,,	28×20, ,,	33/7½
,,	20×10, ,,	23/6
,,	18¾×14, ,,	17/3
Terneplates,	28×20, ,,	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
July 26	63	7	6	No change	
,, 27	63	12	6	inc.	5/-
,, 28	63	17	6	,,	5/-
,, 31	64	5	0	,,	7/6
Aug. 1	64	12	6	,,	7/6

Electrolytic Copper.

July 26	70	10	0	No change	
,, 27	70	10	0	,,	
,, 28	70	10	0	,,	
,, 31	71	0	0	inc.	10/-
Aug. 1	71	0	0	No change	

Standard Tin (cash).

July 26	160	5	0	inc.	40/-
,, 27	162	15	0	,,	50/-
,, 28	161	10	0	dec.	25/-
,, 31	162	10	0	inc.	20/-
Aug. 1	162	15	0	,,	5/-

Tin (English ingots)

July 26	160	0	0	inc.	40/-
,, 27	162	15	0	inc.	55/-
,, 28	161	10	0	dec.	25/-
,, 31	162	10	0	inc.	20/-
Aug. 1	162	15	0	,,	5/-

Zinc Sheets (English).

July 26	36	0	0	No change
,, 27	36	0	0	,,
,, 28	36	0	0	,,
,, 31	36	0	0	,,
Aug. 1	36	0	0	,,

Spelter (ordinary).

July 26	29	17	6	inc.	2/6
,, 27	30	7	6	,,	10/-
,, 28	30	10	0	,,	2/6
,, 31	31	0	0	,,	10/-
Aug. 1	31	10	0	,,	10/-

Lead (English)

July 26	26	15	0	dec.	5/-
,, 27	27	0	0	No change	
,, 28	27	0	0	,,	
,, 31	27	0	0	,,	
Aug. 1	26	15	0	dec.	5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
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WILLIAM JACKS & COMPANY,
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FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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SITUATIONS VACANT AND WANTED.

MOULDER, 38, would like a change, home or abroad, as FOREMAN, or in charge of apprentices. Experienced in Engineering, Railway Work, Locomotive, Moulding Machines, etc.—Apply to Box 220, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234. Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

INDIA.—Assistant Colliery Manager required, on five years' agreement; Rs. 650, Rs. 675, Rs. 700, Rs. 725, Rs. 750 per month, respectively; must hold first-class Colliery Manager's Certificate.—Write, stating age, full particulars, experience, etc., to "Colliery Manager," c/o Deacon's, Leadenhall Street, E.C.3.

PARTNERSHIP OR POST REQUIRED.

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Estimates, Schedules, Weights, Costs, Patterns, Drawings and Works Sketches, Design of Plant, Design of Gear for Moulding Machines, Sprays, Plates, etc. Methods for Mass Production, Gauges, Snags, Prevention of waste. Machine shop practice. Sources of new work. Experience in Railway, Motor, Electric, Machine Tool and General Castings. Technical correspondence. Testing. Marking out. Excellent references. Guarantees. Terminating 3½ years as Technical Chief and Foreman for the Wycliffe Foundry Company, Limited, Lutterworth.

Walter Stanley.

Gilmorton Road, Lutterworth, Leicestershire.

MACHINERY.

FOR SALE.

160-kw. 3-phase Generating Set, by Scott & Mountain, Compound Engine, direct coupled to 3-phase Alternator, 550 volts per phase, 40 cycles, 300 revs. Powerful Electric Winch, drum 3 ft. 6 in. dia., 3 ft. long, Motor 450 amps., 100 volts, 520 revs., by Clarke, Chapman & Company, Limited. 100 b.h.p. 3-phase Slip Ring Motor, ventilated type, 50 periods, 200 volts, 575 revs., by British Thomson Houston Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cyls., 26 in. stroke, by Marshall Sons & Company, Limited. Two Twin Spindle Vertical Boring, Drilling, and Tapping Machines, by D. & J. Tullis, 2¾ in. spindle, T-slotted table working surface, 5 ft. 6 in. x 4 ft. Horizontal Boring Machine, by the Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Worthington Horizontal Duplex Pump, 14 in. x 12 in. x 10 in., 10 in. suction, 8 in. delivery. Surface Condensing Plant, by F. Pearn & Company, 10 in. and 16 in. steam cyls., 12 in. stroke, air pump 18 in., circulating pump 12⅜ in., surface area 1,200 ft. 12 in. stroke Shaping Machine, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

CUPOLA, 3-ton per hour; Staging, Fan, Hoist complete; made by Constructional Engineering Company. Seen working; replacing with larger plant; cheap immediate clearance.—Box 236. Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY FOR SALE.

NINE nearly new 5-ton Hopper Wagons, Standard Gauge, Steel Plate Hoppers; Manning Wardell Locomotive, 9in. Cylinders; two very fine three-throw Hydraulic Pumps, 4½in. rams; 4in. Electric-driven Centrifugal Pump by Gwynnes, 220 volts d.c.; 55-h.p. Horizontal Ruston Crude Oil Engine, latest type.—Full details, Harry H. Gardam & Co, Limited, Staines.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUBALE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MISCELLANEOUS.

NORTHAMPTON IRON ORE.—For sale, by order of Mortgagees, Farm containing 238 acres, valuable bed of Ironstone believed to exist thereunder, land adjoining worked. Above Farm key position to railway and adjoining land. Price freehold (cheap), £12,000.—Apply to Messrs. Merry & Son, Auctioneers, Northampton.

86, Barton Road, Stretford, Manchester.
S. G. SMITH,

Iron Foundry Expert,

Late Foundry Specialist with Metropolitan Vickers Electrical Company, Limited, Trafford Park, Manchester,

Is again available for consultations, investigations, and advice on all matters appertaining to Iron Foundries and Castings.

Upwards of 40 years' active experience of work of all classes.

Author of Articles covering Modern Foundry Practice, including

Foundry Lay-out and Design,
Cast-iron, Analysis and Mixings for Various Castings,
Cupola Practice and Management,
Moulding and Facing Sands, Blackings, etc.,
Loam and Sand Procedures, etc., etc.

Lecturer and Teacher on Foundry Processes at the College of Technology, Manchester.

Practical Tuition to Foundry Students, private, or in classes; also Universities, Colleges, and Technical Schools.

Consultations, away or at home, by appointment
Terms, reasonable and satisfactory.

Special Offer!

3 Morgan tilting furnaces, 300 lb. capacity, gas fired, excellent order **£45** each.

6 Morgan tilting furnaces, 400 lb. capacity, coke fired, excellent order **£80** each.

One Sand Blast Barrel, 3 ft. dia. 4 ft. long, self contained ... ... **£160** each.

ALEX. HAMMOND,
"BOXTED"—SLOUGH.
The Only FOUNDRY Machinery Merchant.

"Coal Economy is in the Air"

On the one hand

Natural Draught with costly brick chimney emitting black smoke that spells waste and the draught at the mercy of the atmospheric conditions.

Send for Catalogue No. 1009

On the other hand

SIROCCO

Induced Draft with inexpensive steel stack and no wasteful smoke because the Fan ensures perfect combustion and correct draught at all times.

DAVIDSON & Co LTD.
SIROCCO WORKS,
BELFAST.
TRADE
SIROCCO
MARK

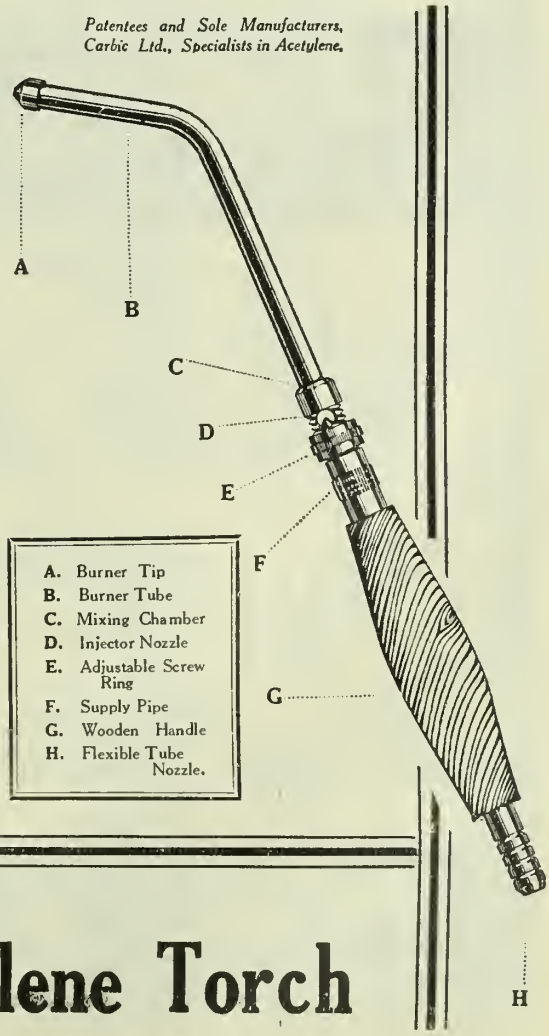
---

3 useful tools in One

Patentees and Sole Manufacturers, Carbic Ltd., Specialists in Acetylene.

HERE is a new and inexpensive 3-in-1 tool that will quickly save its first cost and thereafter give sheer profit. This is how you use the Carbic Adjustable Acetylene Torch. On a large and costly sand-mould, for example: examine deep awkward corners with the torch set to lighting position; without moving the torch move adjusting ring over the air ports to give a clear hot bunsen flame and "dry" the mould—then set the ring to give a smoky soot-laden flame which rapidly deposits an even layer of finely divided 100% pure carbon. A boy can use this new torch efficiently.

The outfit includes a Portable Acetylene Generator and Hose. Made by the makers of Carbic portable oxy-acetylene cutting and welding plants. Send a postcard for the illustrated and priced folder giving the full description.



A. Burner Tip
B. Burner Tube
C. Mixing Chamber
D. Injector Nozzle
E. Adjustable Screw Ring
F. Supply Pipe
G. Wooden Handle
H. Flexible Tube Nozzle.

CARBIC LIMITED
Specialists in Acetylene,
51, Holborn Viaduct, London, E.C.1.
BRANCHES: Liverpool, Newcastle-on-Tyne, Glasgow, Southampton, Leeds, Cardiff, where stocks are always available.

The CARBIC
Adjustable Acetylene Torch

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	65	2	6
Three months	65	2	6
Electrolytic	71	0	0
Tongh	67	0	0
Best selected	67	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	17	6
Do. Aug.	71	17	6
Do. Sept.	71	17	6
Ingot bars	71	10	0
H.C. wire rods	76	5	0
Off. aver. cash, July	63	3	7 3/4
Do. 3 mths., July	63	10	5 1/4
Do. Settlement July	63	3	2 1/4
Do. Electro, July	71	0	0
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July	71	13	7

Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.
Yellow metal rods	6½d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9½d

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13d
Rods, drawn	10⅜d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9¼d.
Rolled metal	9½d.

TIN.

	£	s	d.
Standard cash	161	12	6
Three Months	161	12	6
English	161	10	0
Bars	163	10	0
Chinese	160	5	0
Straits	162	10	0
Australian	162	5	0
Eastern	162	15	0
Banca	161	17	6
Off. aver., cash, July	156	4	4 1/2
Do. 3 mths., July	156	14	5 3/4
Do. Sttlment. July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

	£	s	d.
Ordinary	31	15	0
Remelted	30	0	0
Hard	23	5	0
Electro 99.9	35	15	0
English	32	0	0
India	24	0	0
Prime Western	31	17	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., July	28	18	5 11/14
Aver., spot, July	29	0	10 3/4

LEAD.

	£	s	d.
Soft foreign ppt	25	10	0
English	26	10	0
Off. average, July	24	6	11 7/7
Average spot, July	24	17	4 1/2

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	37	0	0
Do. V.M. ex. whf.	36	10	0
Dutch	36	10	0
Rods	41	15	0
Boiler plates	35	0	0
Battery plates	35	10	0

ANTIMONY.

	£	s	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	24	0	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 5 0 to 11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s	d.
Ferro-silicon—			
45/50%	12	17	6
75%	22	0	0

Ferro-vanadium—
35/40% 17/6 to 17/9 lb. va.

Ferro-molybdenum—
70/75% 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. .. £23 10
8/10% car. .. £23

Ferro-chrome—
Max. 2% car. .. £60
Max. 1% car. .. £70
Max. 0.70% car. .. £78
67/70%, carbonless 1/7½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 10/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb

Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ⅛ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—			
Heavy Steel	3 7 6	3 15	0
Bundled steel & shearings	2 18 0	3 7	6
Mixed iron & steel	2 19 0	3 7	6
Heavy cast iron	3 7 6	3 17	6
Good machinery for foundries	4	2	6
Cleveland—			
Heavy steel	3	2	6
Steel turnings	2	5	0
Cast-iron borings	2	5	0
Heavy forge	3	12	6
Bushelled scrap	3	2	6
Cast-iron scrap	3	19	6
Lancashire—			
Cast iron scrap	4	0	0
Heavy wrought	3	10	0
Steel turnings	2	2	6

	£	s.	d.
London—			
Copper (clean)	55	10	0
Brass (clean)	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	65	0	0
Braziery copper	46	10	0
Gun metal	40	0	0
Hollow pewter	120	0	0
Shaped black pewter	70	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	88/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	93/6
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge 70/- to 72/6	
,, foundry No. 3 77/6	,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/-
,, No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	104/2
W.C. hematite	104/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ¾ in. × 4 in.	20	10	0
Steel—			
Ship plates	9	0	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	8	15	0
Tees	9	15	0
Channels	8	10	0
Joists	9	5	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1½in.	8	10	0

	£	s.	d.
Rails, heavy	9	10	0
Fishplates	14	10	0
Hoops	12	0	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	0	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	14	0	0
Billets, soft	7 0 0 to 7	5	0
Billets, hard	8	0	0
Sheet bars	7 5 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 3
Sheet	1 3¾
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6½ to 2/0½
To 18 in. wide	1/7½ to 2/1½
To 21 in. wide	1/8½ to 2/2½
To 25 in. wide	1/9½ to 2/3½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½ with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	28.77
No. 2 foundry Valley	25.00
No. 2 foundry, Birm.	18.50
Basic	25.96
Bessemer	26.77
Malleable	28.96
Grey forge	26.27
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	1.92
Steel bars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.70
Skelp, sheared steel	1.70
Steel hoops	2.50
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	32/6
,, furnace	22/6
Durham & North. foundry	28/-
,, furnace	23/6
Other Districts, foundry	27/6
,, furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price	£22 to £23
Rolled Ordinary— Assortment ..	£17 0 0 to £17 10 0
Nail Rods— Square, round and flats ..	
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C. Cokes,	20×14, box	19/9
,,	28×20, ,,	39/3
,,	20×10, ,,	27/6
,,	18¾×14, ,,	19/9
I.X.	,	45/6
I.X.X.	,,	52/-
F.C.B.Y.	21×13¾ ,,	37/3
C.V.B.G.	16¾×15, ,,	35/-
I.C.W.	20×14, ,,	16/10½
,,	28×20, ,,	33/7½
,,	20×10, ,,	23/7½
,,	18¾×14, ,,	17/3
Terneplates,	28×20, ,,	36/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Aug. 2	65	7	6	inc.	15/-
,, 3	65	7	6	No change	
,, 4	65	2	6	dec.	5/-
,, 7	—		—		
,, 8	65	2	6	No change	

Electrolytic Copper.

Aug. 2	71	0	0	No change	
,, 3	71	0	0	,,	
,, 4	71	0	0	,,	
,, 7	—		—		
,, 8	71	0	0	No change	

Standard Tin (cash).

Aug. 2	159	15	0	dec.	60/-
,, 3	159	2	6	,,	12/6
,, 4	160	17	6	inc.	35/-
,, 7	—		—		
,, 8	161	12	6	,,	15/-

Tin (English ingots)

Aug. 2	159	15	0	dec.	60/-
,, 3	159	0	0	dec.	15/-
,, 4	161	0	0	inc.	40/-
,, 7	—		—		
,, 8	161	10	0	,,	10/-

Zinc Sheets (English).

Aug. 2	37	0	0	inc.	10/-
,, 3	37	0	0	No change	
,, 4	37	0	0	,,	
,, 7	—		—		
,, 8	37	0	0	,,	

Spelter (ordinary).

Aug. 2	31	17	6	inc.	7/6
,, 3	31	12	6	dec.	5/-
,, 4	31	15	0	inc.	2/6
,, 7	—		—		
,, 8	31	15	0	No change	

Lead (English).

Aug. 2	26	15	0	No change	
,, 3	26	15	0	,,	
,, 4	26	15	0	,,	
,, 7	—		—		
,, 8	26	10	0	dec.	5/-

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
STOURBRIDGE, ENGLAND.

Manufacturers of

FIRE BRICKS, BLAST FURNACE BRICKS & CUPOLA BRICKS.

SHROPSHIRE IRON Co., Ltd.

Works :— Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams :— Sun, Wellington, Salop. Sunbrand (Cannon), London.

Telephone :— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

TO NON-FERROUS FOUNDERS, Etc.

If you need a Foundryman, as Manager, Assistant Manager or Foreman—Advertiser, age 39, with 25 years' practical experience (including plate and machine moulding) acquired as moulder, coremaker, foreman (11 years); with a thorough technical training, I.C.S. diploma modern foundry practice, Member Institute British Foundrymen, a knowledge of Book-keeping, and of costs systems, capable estimator from Blue Prints, and whose motto is, "Efficiency achieves Economy," then please write "J," 196, Merton Road, Wandsworth, London.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN MAKER. Age 30. Large experience in both shop and foundry, desires to obtain employment in modern or progressive foundry where thorough knowledge of machine and plate moulding and foundry work can be obtained, also facilities for studying production and economy desirable.—Apply, Tynesider, Offices of the Foundry Trade Journal, 5, Duke Street, Adelphi, London, W.C.2.

PARTNERSHIP OR POST REQUIRED.

PATTERNS OR FOUNDING.

Estimates, Schedules, Weights, Costs, Patterns, Drawings and Works Sketches, Design of Plant, Design of Gear for Moulding Machines, Sprays, Plates, etc. Methods for Mass Production, Gauges, Snags, Prevention of waste. Machine shop practice. Sources of new work. Experience in Railway, Motor, Electric, Machine Tool and General Castings. Technical correspondence. Testing. Marking out. Excellent references. Guarantees. Terminating 3½ years as Technical Chief and Foreman for the Wycliffe Foundry Company, Limited, Lutterworth.

Walter Stanley.

Gilmorton Road, Lutterworth, Leicestershire.

IRON AND STEEL TRADE.—Active Agent established in the Charleroi district is anxious to meet big exporters wishing to place advantageously in Belgium their orders in bars, joints, tees, angles, etc. —A. G., Eclair Publicite, Charleroi (Belgium).

MACHINERY.

FOR SALE.

20 in. by 9 in. Goodwin Barsby Stone Breaker, fitted with "Era" Manganese Steel Jaws. One 12in. by 8in. Stone Breaker, with steel frame (by Edgar Allens). "Krom-Type" Crushing Rolls, 30in. diam. by 15¾in. wide; with manganese steel shells. "Balfour" Concrete Mixer, 1¼ cub. yards capacity, two hoppers for feeding, f and l. pulleys, water tank, etc. "Taylor" Concrete Mixer, with conical drum 7ft. 6in. diam. Set of Portable Hoisting Gear, with horizontal steam winch cylinders 3½in. diam. by 8in. stroke, on road wheels. One 7ft. and one 10ft. Over Driven Grinding Pans, with grids, etc.

Catalogue of Stock Machinery, 5-6,000 Lots. Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

CUPOLA, 3-ton per hour; Staging, Fan, Hoist complete; made by Constructional Engineering Company. Seen working; replacing with larger plant; cheap immediate clearance.—Box 236, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOR SALE.—LOAM MILL, 4 ft., Pan first-class order, £30; 1- and 2-cwt. Ladles, 2 Cupolas for 2 and 4 tons per hour; Foundry Travelling Crane, 16ft. span, to lift up to 4 tons, £50; quantity Grinding Wheels from 3 in. up to 40 in. diam.; new.—Geo. Dean, Engineer, Vulcan Street, Cobridge, Staffs.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

MACHINERY —*Contd.*

MACHINERY FOR SALE.

NINE nearly new 5-ton Hopper Wagons, Standard Gauge, Steel Plate Hoppers; Manning Wardell Locomotive, 9in. Cylinders; two very fine three-throw Hydraulic Pumps, 4½in. rams; 4in. Electric-driven Centrifugal Pump by Gwynnes, 220 volts d.c.; 55-h.p. Horizontal Ruston Crude Oil Engine, latest type.—Full details, Harry H. Gardam & Co, Limited, Staines.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUBALE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MISCELLANEOUS.

NORTHAMPTON IRON ORE.—For sale, by order of Mortgagees, Farm containing 238 acres, valuable bed of Ironstone believed to exist thereunder, land adjoining worked. Above Farm key position to railway and adjoining land. Price freehold (cheap), £12,000.—Apply to Messrs. Merry & Son, Auctioneers, Northampton.

TO IRON, STEEL, NON-FERROUS FOUNDRIES AND MANUFACTURERS.

Expert metallurgical, analytical and consulting service given by old-established firm of metallurgical chemists (chemical analysis, general foundry work, mixtures, research, etc). Write at once for lists and details.—Beecroft & Partners, Limited, Valley Road, Chesterfield; also at Norfolk House, Cannon Street, Birmingham.

FOR SALE.—FOUNDRY, or would take a Partner, either a Moulder or Pattern Maker; capital required for Partnership £1,250.—Box 238, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

Special Offer!

Two excellent Rumbling Barrels, one 44″ x 20″ by Evans, one 50″ x 28″ by Philips ... ... £18 each

Three brand new centrifugal Sand Mixers, by Geo. Green, 48″ casings, large output ... ... £30 each

6-foot Sand-mill, new false bottom £70

Pneumatic Sand Sifter by Consolidated Pneumatic £15

Belt-driven Sand Sifter £8

ALEX. HAMMOND,
"BOXTED"—SLOUGH.
The Only FOUNDRY Machinery Merchant.

SWEDISH IRON.

Bars, hammered basis sizes Basis price	£22 to £23
Rolled Ordinary— Assortment ..	£ 17 s. 0 d. 0 to
Nail Rods— Square, round and flats ..	17 10 0
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/4½
,,	28×20, ,,	38/10½
,,	20×10, ,,	27/9
,,	18¾×14, ,,	19/7½
I.X.	,	45/6
I.X.X.	,,	52/-
F.C.B.Y.	21×13¾ ,,	38/3
C.V.B.G.	16¾×15, ,,	35/
I.C.W.	20×14, ,,	17/-
,,	28×20, ,,	34/
,,	20×10, ,,	23/7½
,,	18¾×14, ,,	17/3
Terneplates,	28×20, ,,	35/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Aug. 9	64	12	6	dec.	10/-
,, 10	64	2	6	,,	10/-
,, 11	64	2	6	No change	
,, 14	64	2	6	,,	
,, 15	63	17	6	dec.	5/-

Electrolytic Copper.

Aug. 9	71	0	0	No change	
,, 10	70	10	0	dec.	10/-
,, 11	70	10	0	No change	
,, 14	70	0	0	dec.	10/-
,, 15	70	0	0	No change	

Standard Tin (cash).

Aug. 9	160	2	6	dec.	30/-
,, 10	159	2	6	,,	20/-
,, 11	158	10	0	,,	12/6
,, 14	158	15	0	inc.	5/-
,, 15	158	17	6	,,	2/6

Tin (English ingots)

Aug. 9	160	0	0	dec.	30/-
Aug. 10	159	0	0	dec.	20/-
,, 11	158	10	0	,,	10/-
,, 14	158	10	0	No change	
,, 15	158	15	0	inc.	5/-

Zinc Sheets (English)

Aug. 9	37	10	0	inc.	10/-
,, 10	37	10	0	No change	
,, 11	37	10	0	,,	
,, 14	37	10	0	,,	
,, 15	37	10	0	,,	

Spelter (ordinary).

Aug. 9	31	10	0	dec.	5/-
,, 10	31	5	0	,,	5/-
,, 11	31	0	0	,,	5/-
,, 14	31	5	0	inc.	5/-
,, 15	31	5	0	No change	

Lead (English)

Aug. 9	26	10	0	No change	
,, 10	26	5	0	dec.	5/-
,, 11	26	0	0	,,	5/-
,, 14	26	0	0	No change	
,, 15	26	0	0	,,	

We manufacture and can supply immediately

LOW GRADE

FERRO SILICON

8/10% 10/12% 12/15% and 20/25%.

THE NEWCASTLE ALLOY CO., LTD.,

Milburn House,
Newcastle-on-Tyne.

Telephone: 800 CITY (7 lines).
Telegrams: ALLOY, NEWCASTLE-ON-TYNE.

GIVE THE BRITISH MANUFACTURER FIRST CHANCE.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

TO NON-FERROUS FOUNDERS, Etc.

If you need a Foundryman, as Manager, Assistant Manager or Foreman—Advertiser, age 39, with 25 years' practical experience (including plate and machine moulding) acquired as moulder, coremaker, foreman (11 years); with a thorough technical training, I.C.S. diploma modern foundry practice, Member Institute British Foundrymen, a knowledge of Book-keeping, and of costs systems, capable estimator from Blue Prints, and whose motto is, "Efficiency achieves Economy," then please write "J," 196, Merton Road, Wandsworth, London.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN MAKER. Age 30. Large experience in both shop and foundry, desires to obtain employment in modern or progressive foundry where thorough knowledge of machine and plate moulding and foundry work can be obtained, also facilities for studying production and economy desirable.—Apply, Tynesider, Offices of the Foundry Trade Journal, 5, Duke Street, Adelphi, London, W.C.2.

IRON AND STEEL TRADE.—Active Agent established in the Charleroi district is anxious to meet big exporters wishing to place advantageously in Belgium their orders in bars, joints, tees, angles, etc. —A. G., Eclair Publicite, Charleroi (Belgium).

EXPERT FOR FOUNDRY TECHNICAL INSTITUTE, FALKIRK, WANTED. State age, experience (including teaching), salary required, etc. Replies to James Allen, 24, Newmarket Street, Falkirk.

MACHINERY.

FOR SALE.

160-kw. 3-phase Generating Set, by Scott & Mountain, Compound Engine, direct coupled to 3-phase Alternator 550 volts per phase, 40 cycles, 300 revs. Powerful Electric Winch, drum 3 ft. 6 in. dia., 3 ft. long, Motor 450 amps., 100 volts, 520 revs., by Clarke, Chapman & Company, Limited. 100 b.h.p. 3-phase Slip Ring Motor, ventilated type, 50 periods, 200 volts, 575 revs., by British Thomson Houston Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cyls., 26 in. stroke, by Marshall Sons & Company, Limited. Two Twin Spindle Vertical Boring, Drilling and Tapping Machines, by D. & J. Tullis, 2¾ in. spindle, T-slotted table working surface, 5 ft. 6 in. x 4 ft. Horizontal Boring Machine, by the Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Worthington Horizontal Duplex Pump, 14 in. x 12 in. x 10 in., 10 in. suction, 8 in. delivery. Surface Condensing Plant, by F. Pearn & Company, 10 in. and 16 in. steam cyls., 12 in. stroke, air pump 18 in., circulating pump 12¾ in., surface area 1,200 ft., 12 in. stroke Shaping Machine, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

55 H.P. Vertical Petter Crude Oil Engine; two Magnificent Electric 3-throw Hydraulic Pumps, 4½in. rams, 220 volts d.c.; 2½in. and 4in. Electric Centrifugal Pumps, 220 volts d.c.; nine, nearly new, 5-Ton Hopper Wagons; Manning Wardell Locomotive, 9in. cylinders. Details.—Harry H. Gardam & Company, Limited, Staines.

MACHINERY —*Contd.*

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and, particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining.

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUBALE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MISCELLANEOUS.

S. G. SMITH,

Iron Foundry Expert,

Late Foundry Specialist with Metropolitan Vickers Electrical Company, Limited, Traffford Park, Manchester,

Is again available for consultations, investigations, and advice on all matters appertaining to Iron Foundries and Castings.

Upwards of 40 years' active experience of work of all classes.

Author of Articles covering Modern Foundry Practice, including

Foundry Lay-out and Design,
Cast-iron. Analysis and Mixings for Various Castings,
Cupola Practice and Management,
Moulding and Facing Sands, Blackings, etc.,
Loam and Sand Procedures, etc., etc.,

Lecturer and Teacher on Foundry Processes at the College of Technology, Manchester.

Practical Tuition to Foundry Students, private, or in classes; also Universities, Colleges, and Technical Schools.

Consultations, away or at home, by appointment. Terms, reasonable and satisfactory.

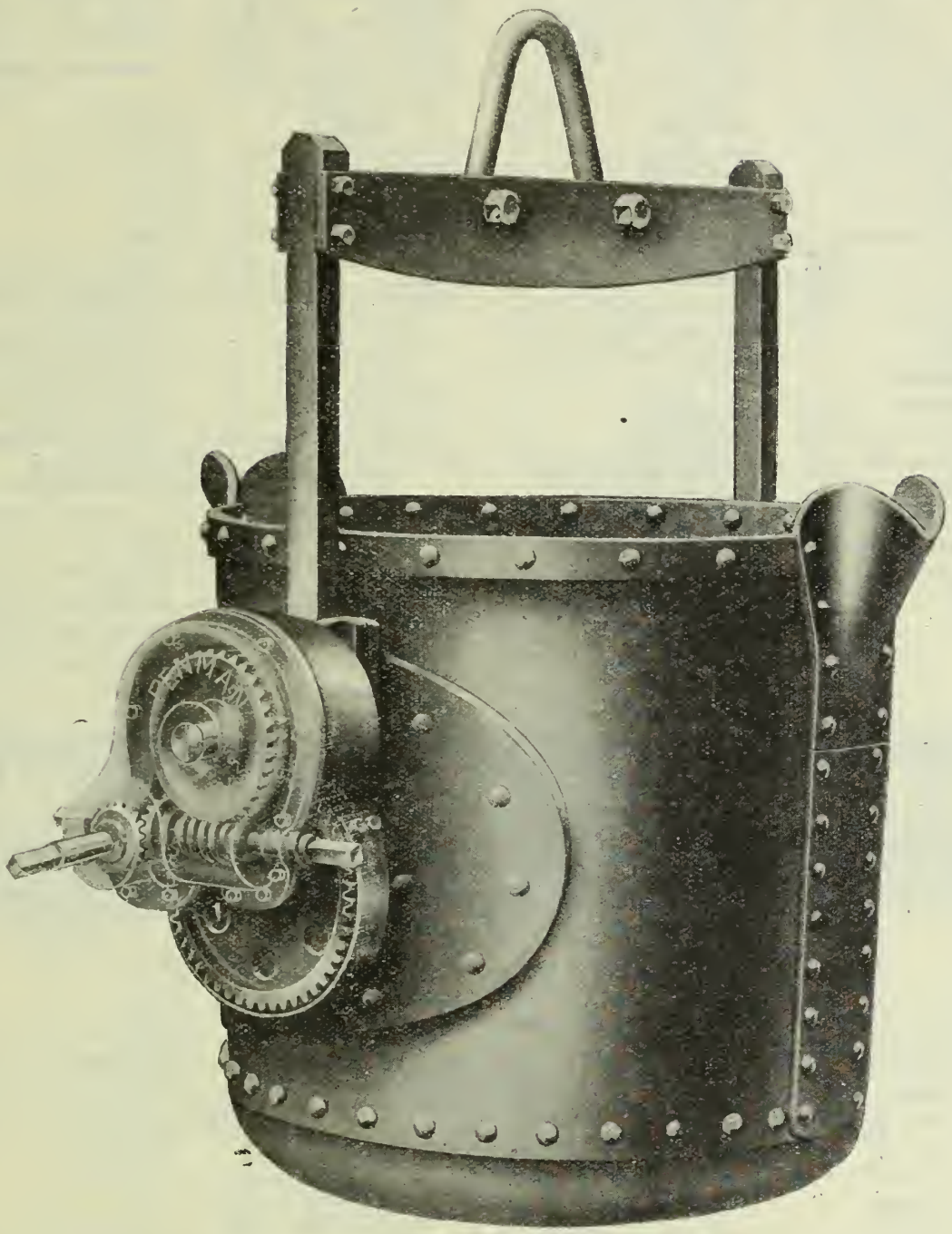
MOULDING MACHINES.

One Tabor Jolt Ram Stripping plate machine for boxes 26″ x 26″	£100	
Four Tabor Split pattern power draft squeezers for boxes 16″ x 14″	£80	each
Two Mumford Split pattern power draft squeezers for boxes 18″ x 12″	£80	each
Two Tabor Split pattern power draft squeezers for boxes 18″ x 18″	£90	each
One Darling & Sellars hand-ram turnover machine for boxes 36″ x 24″	£30	
One Darling & Sellars hand-ram turnover machine for boxes 20″ x 16″	£25	
Two Evans flypress New hand squeezers for boxes 16″ x 16″	£12	each
Two Evans Duplex pneumatic squeezers for boxes 20″ x 20″	£90	each

ALEX. HAMMOND,
"BOXTED"—SLOUGH.
All the above in my Stock at Slough.

Small Advertisements continued on p. 15.

PENMAN'S LADLES



GEARED CRANE LADLE.

Type F.

Penman & Company, Ltd.

Caledonian Iron Works,
GLASGOW.

Telegrams :
PENMAN, GLASGOW

Telephone :
BRIDGETON 41 & 42.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	10	0
Three months	63	12	6
Electrolytic	69	15	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	70	15	0
Do. Aug.	70	15	0
Do. Sept.	70	15	0
Ingot bars	70	15	0
H.C. wire rods	75	10	0
Off. aver. cash, July	63	3	7 3/14
Do. 3 mths., July	63	10	5 5/14
Do. Settlement July	63	3	2 4/7
Do. Electro, July	71	0	0
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July	71	13	7

Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.
Yellow metal rods	6¾d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9¼d

BRASS.

Solid drawn tubes	11¾d.
Brazed tubes	13½d
Rods, drawn	10⅜d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9⅞d.
Rolled metal	9½d.

TIN.

	£	s	d.
Standard cash	160	5	0
Three Months	160	7	6
English	159	15	0
Bars	161	15	0
Chinese	159	0	0
Straits	161	5	0
Australian	160	10	0
Eastern	162	5	0
Banca	160	7	6
Off. aver., cash, July	156	4	4 1/7
Do. 3 mths., July	156	14	5 4/7
Do. Sttlment. July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

	£	s	d.
Ordinary	31	5	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	35	10	0
English	31	15	0
India	24	0	0
Prime Western	31	12	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., July	28	18	5 11/14
Aver., spot, July	29	0	10¾

LEAD.

	£	s	d.
Soft foreign ppt	25	2	6
English	26	0	0
Off. average, July	24	6	11¼
Average spot, July	24	17	4½

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	37	10	0
Dutch	37	10	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

	£	s	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	15	0	0

QUICKSILVER.

Quicksilver £11 15 0 to £11 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s	d.
Ferro-silicon—			
45/50%	12	17	6
75%	21	15	0
Ferro-vanadium— 35/40%	17/6 lb. va.		
Ferro-molybdenum— 70/75%	6/6 lb. mo.		
Ferro-titanium— 23/25%, carbonless	1/2 lb.		
Ferro-phosphorus, 20/23%	£20		
Ferro-tungsten— 80/85%, carbon free	1/5 lb.		
Tungsten metal powder— 98/99%	1/9½ lb.		
Ferro-chrome— 4/6% car.	£23		
6/8% car.	£22 10		
8/10% car.	£22		
Ferro-chrome— Max. 2% car.	£60		
Max. 1% car.	£68		
Max. 0.70% car.	£75		
67/70%, carbonless	1/7 lb.		
Nickel—99%, cubes or pellets	£150		
Cobalt metal—98/99%	10/6 lb.		
Aluminium—98/99%	£100		
Metallic Chromium— 96/98%	5/- lb		
Ferro-manganese (net)— 76/80%, loose	£15		
76/80%, packed	£16		
76/80%, export	£14 10		
Metallic manganese— 94/96%, carbonless	2/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections	6d. lb.
If in coils	3d. lb.
Packing	£3 ton.
Bars cut to length	10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	8	6	3	15	0
Bundled steel & shearings	2	17	6	3	7	6
Mixed iron & steel	2	17	6	3	5	0
Heavy cast iron	3	7	6	3	15	0
Good machinery for foundries				3	17	6
Cleveland—						
Heavy steel				3	2	6
Steel turnings				2	5	0
Cast-iron borings				2	5	0
Heavy forge				3	12	6
Bushelled scrap				3	2	6
Cast-iron scrap				3	12	6
Lancashire—						
Cast iron scrap				4	0	0
Heavy wrought				3	10	0
Steel turnings				2	2	6
London—						
Copper (clean)				57	0	0
Brass (clean)				31	0	0
Lead (less usual draft)				20	0	0
Tea lead				18	0	0
Zinc				17	0	0
New aluminium cuttings				60	0	0
Brazierv copper				47	0	0
Gun metal				41	0	0
Hollow pewter				125	0	0
Shaped black pewter				80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	87/-
Forge No. 4	83/-
Mottled	80/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/-
,, No. 3	95/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	101/2
W.C. hematite	104/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.) £10 10 to £11	10	0	
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ¾ in. × 4 in.	19	10	0
Steel—			
Ship plates	9	0	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	8	15	0
Tees	9	12	6
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1¼in.	8	10	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	15	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	14	0	0
Billets, soft	7 0 0 to 7	5	0
Billets, hard	8	0	0
Sheet bars	7 5 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 3
Sheet	1 3¾
Wire	1 3¾
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5¼ to 1/11¼
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6¾ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	31.14
No. 2 foundry Valley	29.00
No. 2 foundry, Birm.	19.50
Basic	27.96
Bessemer	28.76
Malleable	29.96
Grey forge	28.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.02
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.50
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
,, furnace	30/-
Durham & North. foundry	28/-
,, furnace	23/6
Other Districts, foundry	27/6
,, furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £17 0 0 to £17 10 0

Nail Rods— Square, round and flats .. £17 0 0 to £17 10 0

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	.. 55%	Tube prices are now free.
Water	.. 50%	
Steam	.. 45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/3
,,	28×20, ,,	38/10½
,,	20×10, ,,	27/9
,,	18¾×14, ,,	19/9
I.X.	,	45/6
I.X.X.	,,	52/-
F.C.B.Y.	21×13⅝ ,,	37/-
C.V.B.G.	16¾×15, ,,	35/6
I.C.W.	20×14, ,,	17/-
,,	28×20, ,,	34/3
,,	20×10, ,,	23/3
,,	18¾×14, ,,	18/11½
Terneplates,	28×20, ,,	35/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Aug. 16	64	5	0	inc.	7/6
,, 17	64	0	0	dec.	5/-
,, 18	63	17	6	,,	2/6
,, 21	63	15	0	,,	2/6
,, 22	63	10	0	,,	5/-

Electrolytic Copper.

Aug. 16	70	5	0	inc.	5/-
,, 17	70	0	0	dec.	5/-
,, 18	70	0	0	No change	
,, 21	69	15	0	dec.	5/-
,, 22	69	15	0	No change	

Standard Tin (cash).

Aug. 16	160	12	6	inc.	35/-
,, 17	161	10	0	,,	17/6
,, 18	161	12	6	,,	2/6
,, 21	161	2	6	dec.	10/-
,, 22	160	5	0	,,	17/6

Tin (English ingots)

Aug. 16	160	10	0	inc.	35/-
,, 17	161	10	0	inc.	20/-
,, 18	161	10	0	No change	
,, 21	161	0	0	dec.	10/-
,, 22	159	15	0	,,	25/-

Zinc Sheets (English).

Aug. 16	37	10	0	No change
,, 17	37	10	0	,,
,, 18	37	10	0	,,
,, 21	37	10	0	,,
,, 22	37	10	0	,,

Spelter (ordinary).

Aug. 16	31	10	0	inc.	5/-
,, 17	31	12	6	,,	2/6
,, 18	31	10	0	dec.	2/6
,, 21	31	12	6	inc.	2/6
,, 22	31	5	0	dec.	7/6

Lead (English).

Aug. 16	26	0	0	No change
,, 17	26	0	0	,,
,, 18	26	0	0	,,
,, 21	26	0	0	,,
,, 22	26	0	0	,,

SHROPSHIRE IRON Co., Ltd.

Works :—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams :—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone :—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE

in IRON, STEEL, COPPER and BRONZE.

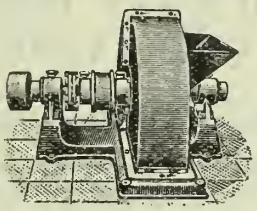
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

THE "BREAKIR" is the most Simple, Reliable, and Efficient SAND MIXER on the Market.



LOW power consumption.

CLEAN and Sounder Castings, therefore a good investment.

CAPACITIES:
1 to 6 tons per hour.

Ask for Illustrated List

W. BREALEY & CO., LTD.,

Russell Street, SHEFFIELD.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN MAKER. Age 30. Large experience in both shop and foundry, desires to obtain employment in modern or progressive foundry where thorough knowledge of machine and plate moulding and foundry work can be obtained, also facilities for studying production and economy desirable.—Apply, Tynesider, Offices of the Foundry Trade Journal, 5, Duke Street, Adelphi, London, W.C.2.

MOULDER, 12 years' experience Aluminium and Brass, over 2 years as Pattern Plate Moulder for Machine Moulding, for British and French machines, including Britannia, and Bonvillain and Ronceray, seeks position, any district.—Box 240, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

IRON AND STEEL TRADE.—Active Agent established in the Charleroi district is anxious to meet big exporters wishing to place advantageously in Belgium their orders in bars, joints, tees, angles, etc. —A. G., Eclair Publicite, Charleroi (Belgium).

THE BRITISH CAST IRON RESEARCH ASSOCIATION

Appointment of Director of Research.

The Council invite applications for the post of Director of Research of the Association at a commencing Salary not exceeding £900 per annum, according to Scientific attainments, and Foundry, Blast Furnace or other suitable Industrial experience.

Forms of application can be obtained from the undersigned, which are to be returned on or before August 31st, 1922.—THOMAS VICKERS, Secretary, Central House, New Street, Birmingham.

MACHINERY.

FOR SALE.

Two new Thompson Dish-ended Lancashire Boilers, 30 ft. x 8 ft. 3 in., for 150 lbs. pressure. Three Lancashire Boilers, 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Two Cornish Boilers, 28 ft. x 6 ft. diameter, reinsure 90 lbs. pressure. Four Marine Water Tube Boilers, by Yarrow, Limited, each 4,000 sq. ft. heating surface, reinsure 200 lbs. pressure. One Loco Type Boiler, barrel 7 ft. 6 in. long x 3 ft. diameter, reinsure 80 lbs. pressure. One Vertical Boiler, 6 ft. 6 in. x 3 ft. 9 in. diameter, reinsure 80 lbs. pressure. One Hornsby Waste Heat Water Tube Boiler, about 40 h.p., reinsure 160 lbs. pressure. Air Receivers, 6 ft. x 2 ft. 6 in., tested to 90 lbs. pressure, with safety valve, drain cock, etc.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY —*Contd.*

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—Harry H. Gardam & Company, Limited, Staines.

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—Stansell's Acetylene Company, Limited, Exeter.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining.

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUABLE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

FIREBRICKS, about 30,000, standard size, for immediate sale; price 98s. 6d. per thousand on rails.—Full details and delivered quotations on application to Thomas Brooke & Sons, Limited, Stocksbridge, near Sheffield.

TO IRON, STEEL, NON-FERROUS FOUNDRIES AND MANUFACTURERS.

Expert metallurgical, analytical and consulting service given by old-established firm of metallurgical chemists (chemical analysis, general foundry work, mixtures, research, etc). Write at once for lists and details.—Beecroft & Partners, Limited, Valley Road, Chesterfield; also at Norfolk House, Cannon Street, Birmingham.

MODERN PLANT

Two NEW sand mixers, largest size, by Green.	£30 each
Pneumatic sand sifter by Consolidated Pneumatic Tool Co.	£18
Belt driven sifter, good machine	£8
4 foot sand mill, double reduction gear, a really first class machine	£30
Four small **turnover** moulding machines by J. C. L. J. W. Phillips.	£14 each
2½ ton Evans crane ladle, as new.	£38
NEW double-ended shanks, 2½ cwt.	£5 each
NEW single-ended shanks, 2 cwt.	£4 each
NEW single-ended shanks, 1 cwt.	£3 each
NEW hand ladles	£1 each

A Stock of foundry small tools, crucible tongs, moulding boxes and machines can always be viewed here.

ALEX. HAMMOND
FOUNDRY MACHINERY MERCHANT
"BOXTED" SLOUGH.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

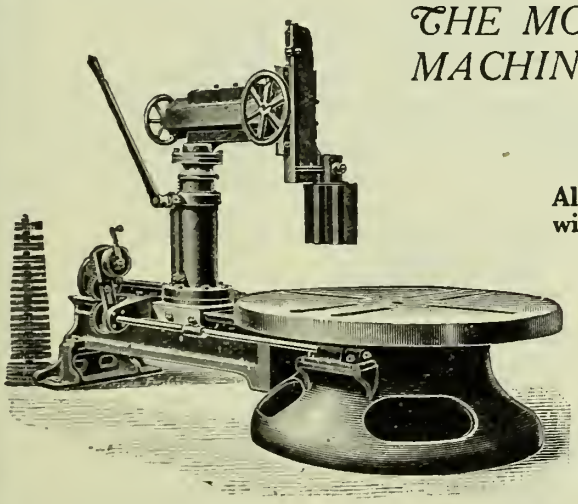
FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 feet diameter can be made.



THE MOST COMPLETE & EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WILLIAM WHITTAKER & SONS, Ltd.

SUN IRON WORKS - - - OLDHAM.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	10	0
Three months	62	15	0
Electrolytic	68	15	0
Tough	65	5	0
Best selected	65	5	0
Sheets	94	0	0
India	84	0	0
Wire bars	69	10	0
Do. Sept.	69	10	0
Do. Oct.	69	10	0
Ingot bars	69	10	0
H.C. wire rods	75	0	0
Off. aver. cash, July 63	3	7	3/4
Do. 3 mths., July 63	10	5	5/8
Do. Settlement July 63	3	2	1/4
Do. Electro, July 71	0	0	
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July 71	13	7	

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11¾d.
Brazed tubes 13½d
Rods, drawn 10⅝d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9⅞d.
Rolled metal 9½d.

TIN.

Standard cash	159	10	0
Three Months	159	15	0
English	159	0	0
Bars	161	0	0
Chinese	158	0	0
Straits	160	0	0
Australian	160	0	0
Eastern	160	5	0
Banca	159	12	6
Off. aver., cash, July	156	4	4 1/7
Do. 3 mths., July	156	14	5¼
Do. Sttlment. July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

Ordinary	31	0	0
Remelted	29	10	0
Hard	23	0	0
Electro 99.9	35	5	0
English	31	2	6
India	23	10	0
Prime Western	31	0	0
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., July	28	18	5 1/14
Aver., spot, July	29	0	10¾

LEAD.

Soft foreign ppt	24	7	6
English	25	10	0
Off. average, July	24	6	11¼
Average spot, July	24	17	4½

ZINC SHEETS.

Zinc sheets, English	37	0	0
Do. V.M. ex. whf.	37	10	0
Dutch	37	0	0
Rods	42	0	0
Boiler plates	35	0	0
Battery plates	35	10	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	15	0	0

QUICKSILVER.

Quicksilver 12 10 0 to 12 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	12 5 0
75%	21 10 0
Ferro-vanadium— 35/40%	17/6 lb. va.
Ferro-molybdenum— 70/75%	6/6 lb. mo.
Ferro-titanium— 23/25%, carbonless	1/1 lb.
Ferro-phosphorus, 20/23%,	£20
Ferro-tungsten— 80/85%, carbon free	1/5 lb.
Tungsten metal powder— 98/99%	1/9½ lb.
Ferro-chrome— 4/6% car.	£23 10
6/8% car.	£23
8/10% car.	£22 10
Ferro-chrome— Max. 2% car.	£60
Max. 1% car.	£70
Max. 0.70% car.	£78
67/70%, carbonless	1/7 lb.
Nickel—99%, cubes or pellets	£150
Cobalt metal—98/99%	10/6 lb.
Aluminium—98/99%	£100
Metallic Chromium— 96/98%	5/- lb
Ferro-manganese(net)— 76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14 10
Metallic manganese— 94/96%, carbonless	2/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s. d.
Finished bars, 14% tungsten	2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	6	3	7	6
Mixed iron & steel	2	17	6	3	5	0
Heavy cast iron	3	5	0	3	17	6
Good machinery for foundries				4	0	0
Cleveland—						
Heavy steel				3	2	6
Steel turnings				2	5	0
Cast-iron borings				2	5	0
Heavy forge				3	12	6
Bushelled scrap				3	2	6
Cast-iron scrap				3	12	6
Lancashire—						
Cast iron scrap				4	0	0
Heavy wrought				3	10	0
Steel turnings				2	2	6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	31	0	0
Lead (less usual draft)	20	0	0
Tea lead	18	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	47	0	0
Gun metal	41	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	87/-
Forge No. 4	84/-
Mottled	80/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge 70/- to	72/6
,,foundry No. 3 77/6 ,,	80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/-
,, No. 3	95/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	101/-
W.C. hematite	105/-

All d/d in the district.

Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ¾ in. × 4 in.	19	10	0
Steel—			
Ship plates	9	10	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	8	15	0
Tees	9	12	6
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	10	0	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1½in.	8	10	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	14	0	0
Billets, soft	7 2 6 to 7	5	0
Billets, hard	8	0	0
Sheet bars	7 0 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3¼
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	33.14
No. 2 foundry Valley	30.00
No. 2 foundry, Birm.	19.50
Basic	27.96
Bessemer	28.76
Malleable	29.96
Grey forge	30.00
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.50
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
,, furnace	30/-
Durham & North. foundry	28/-
,, furnace	23/6
Other Districts, foundry	27/6
,, furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £17 0 0 to £17 10 0

Nail Rods— Square, round and flats ..

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms— Single welded .. £10 to £11

Billets— Single and double welded £13 to £14

Pig-Iron— Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

		Up to and incl. 6 in.
Gas	..	55%
Water	..	50%
Steam	..	45%

Tube prices are now free.

TINPLATES.

I.C. Cokes,	20×14, box		19/3
,,	28×20,	,,	38/9
,,	20×10,	,,	27/9
,,	18¾×14,	,,	19/7½
I.X.		,	45/6
I.X.X.		,,	52/-
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	17/-
,,	28×20,	,,	33/9
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Terneplates,	28×20.	,,	35/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Aug. 23	63	2	6	dec.	7/6
,, 24	62	7	6	,,	15/-
,, 25	61	12	6	,,	15/-
,, 28	62	0	0	inc.	7/6
,, 29	62	10	0	,,	10/-

Electrolytic Copper.

Aug. 23	69	5	0	dec.	10/-
,, 24	69	0	0	,,	5/-
,, 25	68	0	0	,,	20/-
,, 28	68	10	0	inc.	10/-
,, 29	68	15	0	,,	5/

Standard Tin (cash).

Aug. 23	160	0	0	dec.	5/-
,, 24	158	15	0	,,	25/-
,, 25	157	10	0	,,	25/-
,, 28	158	7	6	inc.	17/6
,, 29	159	10	0	,,	22/6

Tin (English ingots)

Aug. 23	159	10	0	dec.	5/-
Aug. 24	158	5	0	dec.	25/-
,, 25	157	5	0	,,	20/-
,, 28	158	0	0	inc.	15/-
,, 29	159	0	0	,,	20/-

Zinc Sheets (English).

Aug. 23	37	10	0	No change	
,, 24	37	10	0	,,	
,, 25	37	0	0	dec.	10/-
,, 28	37	0	0	No change	
,, 29	37	0	0	,,	

Spelter (ordinary).

Aug. 23	31	10	0	inc.	5/-
,, 24	31	0	0	dec.	10/-
,, 25	30	7	6	,,	12/6
,, 28	20	15	0	inc.	7/6
,, 29	31	0	0	,,	5/

Lead (English).

Aug. 23	26	0	0	No change	
,, 24	25	10	0	dec.	10/-
,, 25	25	0	0	,,	10/-
,, 28	25	0	0	No change	
,, 29	25	10	0	inc.	10/

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.
Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.
BEST H. C. COPPER & BRONZE WIRE a speciality.
Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.
REGISTERED TRADE MARK
1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining.

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUABLE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MACHINERY.

WANTED, a Second-hand Adaptable Stripping Machine, medium size. State where same can be viewed, and price.—Apply, Box 242, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, Drop Moulding Machine to take boxes 24 in. square, for hand power. Also quantity of Boxes suitable for same.—The Northern Press Engineering Company, Limited, South Shields.

FOR SALE.

Two new Thompson Dish-ended Lancashire Boilers, 30 ft. x 8 ft. 3 in., for 150 lbs. pressure. Three Lancashire Boilers, 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Two Cornish Boilers, 28 ft. x 6 ft. diameter, reinsure 90 lbs. pressure. Four Marine Water Tube Boilers, by Yarrow, Limited, each 4,000 sq. ft. heating surface, reinsure 200 lbs. pressure. One Loco Type Boiler, barrel 7 ft. 6 in. long x 3 ft. diameter, reinsure 80 lbs. pressure. One Vertical Boiler, 6 ft. 6 in. x 3 ft. 9 in. diameter, reinsure 80 lbs. pressure. One Hornsby Waste Heat Water Tube Boiler, about 40 h.p., reinsure 160 lbs. pressure. Air Receivers, 6 ft. x 2 ft. 6 in., tested to 90 lbs. pressure, with safety valve, drain cock, etc.

Catalogue of Stock Machinery, 5-6,000 Lots. Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

MACHINERY —*Contd.*

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—Stansell's Acetylene Company, Limited, Exeter.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—Harry H. Gardam & Company, Limited, Staines.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

S. G. SMITH,

Iron Foundry Expert,

Late Foundry Specialist with Metropolitan Vickers Electrical Company, Limited, Traffford Park, Manchester,

Is again available for consultations, investigations, and advice on all matters appertaining to Iron Foundries and Castings.

Upwards of 40 years' active experience of work of all classes.

Author of Articles covering Modern Foundry Practice, including

Foundry Lay-out and Design,
Cast-iron. Analysis and Mixings for Various Castings,
Cupola Practice and Management,
Moulding and Facing Sands, Blackings, etc.,
Loam and Sand Procedures, etc., etc.,

Lecturer and Teacher on Foundry Processes at the College of Technology, Manchester.

Practical Tuition to Foundry Students, private, or in classes; also Universities, Colleges, and Technical Schools.

Consultations, away or at home, by appointment.

Terms, reasonable and satisfactory.

CUPOLAS

30-in. ALLDAY'S CUPOLA with hoist, staging, 20ft. by 10ft. and roof, complete installation £150 f.o.r., standing in London.

42-in. WHITING CUPOLA, with spark arrester, staging, hoist, etc., ready for immediate use, and complete in every detail, £380 f.o.r. London, for the entire plant, including 3 phase, 50 cycle, 415 volt electric hoist, and electric blower, same voltage.

URGENTLY REQUIRED

2-ton stock oil-fired converter. Two small tilting cupolettes. Also **all kinds** of surplus foundry plant **for re-sale.** Please send offers to—

ALEXANDER HAMMOND,
Foundry Machinery Merchant,
"BOXTED," SLOUGH.

SCRAP ALL YOUR CRUCIBLES

See Displayed Advertisement last week.

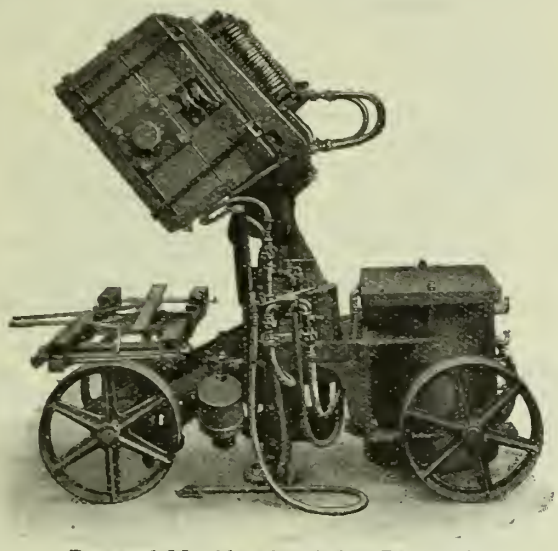
For Prices and particulars apply to :—

BRITISH REVERBERATORY FURNACES LTD.

82, Victoria Street London, S.W.1.

Branch Office: Winchester House, Victoria Square, Birmingham. Telephone: Victoria 6971.

MACNAB & CO.



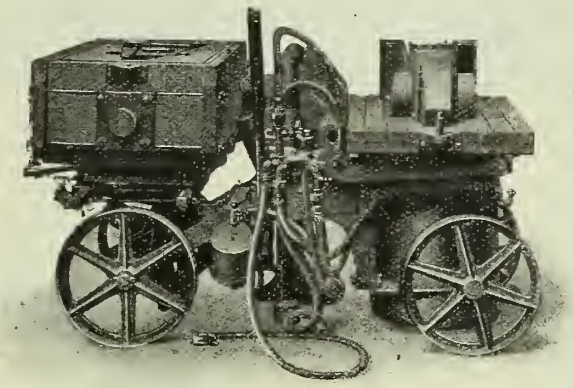
Box and Mould—after being Rammed—
in position of being Rolled over

Tabor Patent
Portable
Combination
Shockless Jarring
Roll - over
AND
Pattern - Drawing

MOULDING MACHINE

Capacities and Dimensions furnished upon application.

We make various models and sizes for all types of machine moulding, according to class of work and numbers.



The Finished Mould—showing Pattern
after being drawn.

Send us Drawings of your work for Specific Expert Advice, according to your conditions and quantities.

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	0	0
Three months	63	7	6
Electrolytic	70	5	0
Tough	65	15	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	70	15	0
Do. Sept.	70	15	0
Do. Oct.	70	15	0
Ingot bars	70	10	0
H.C. wire rods	75	15	0
Off. aver. cash, Aug.	63	16	9 9/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 2/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug.	67	6	8
Aver. spot price, copper, Aug.	63	16	1¾
Do. Electro, Aug.	70	18	7½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6¾d.
Do. 4x4 Sqnares 8¼d.
Do. 4x3 Sheets 9¼d

BRASS.

Solid drawn tnbes 11¾d.
Brazed tubes 13½d
Rods, drawn 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9¾d.
Rolled metal 9½d.

TIN.

	£	s.	d.
Standard cash	159	10	0
Three Months	159	17	6
English	159	0	0
Bars	161	2	6
Chinese	158	2	6
Straits	160	2	6
Australian	160	2	6
Eastern	162	10	0
Banca	159	15	0
Off. aver, cash, Aug.	160	1	0 3/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Sttlment. Aug.	160	1	7 1/11
Aver. spot, Aug.	160	0	5½

SPELTER.

	£	s.	d.
Ordinary	31	5	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	34	5	0
English	31	12	6
India	24	0	0
Prime Western	31	10	0
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., Aug.	30	16	3
Aver., spot, Aug.	31	3	5

LEAD.

	£	s.	d.
Soft foreign ppt	24	10	0
English	25	10	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	0	0
Dntch	37	10	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

	£	s.	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	15	0

QUICKSILVER.

Quicksilver 12 10 0 to 12 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £12 5 0
75% £21 10 0

Ferro-vanadium—
35/40% 17/6 lb. va.

Ferro-molybdenum—
70/75% 7/9 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/3 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% 1/9½ lb.

Ferro-chrome—
4/6% car. £23 0
6/8% car. £22 10
8/10% car. £22 0

Ferro-chrome—
Max. 2% car. £60
Max. 1% car. £68
Max. 0.70% car. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 11/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% 5/- lb

Ferro-manganese(net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	6	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron	3	5	0	3	17	6
Good machinery for foundries				4	0	0

Cleveland—			
Heavy steel	3	5	0
Steel turnings	2	7	6
Cast-iron borings	2	7	6
Heavy forge	3	12	6
Bushelled scrap	3	2	6
Cast-iron scrap	3	7	6

Lancashire—			
Cast iron scrap	4	0	0
Heavy wrought	3	10	0
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	20	0	0
Tea lead	18	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	87/6
Forge No. 4	84/-
Mottled	80/-
Hematite No. 1	89/6
Hematite M/Nos.	89/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	102/6
,, No. 3	97/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	100/-
W.C. hematite	105/-

All d/d in the district.

Lancashire (d/d eq. Man.) —	
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	113/6
Glengarnock foundry	115/6
Gartsherrie fonndry	115/6
Monkland foundry	113/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ⅜ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	£8 15 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	10	0	0
Rounds, under 3in. to ⅜in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1½in.	8	10	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	13	0	0
Billets, soft	7 0 0 to 7	5	0
Billets, hard	8	0	0
Sheet bars	7 0 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 3
Sheet	1 3¾
Wire	1 3¼
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11¼
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6¾ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	33.14
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	20.00
Basic	27.96
Bessemer	31.76
Malleable	33.46
Grey forge	34.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	37.50
O.-h. billets	37.50
O.-h. sheet bars	37.50
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.15
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/- to 40/-
,, furnace 30/- to 32/6
Durham & North. foundry 28/-
,, furnace 23/6
Other Districts, foundry 27/6
,, furnace 22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £17 0 0 to £17 10 0

Nail Rods— Square, round and flats .. £17 0 0 to £17 10 0

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms— Single welded .. £10 to £11

Billets— Single and double welded £13 to £14

Pig-Iron— Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box		19/3
,,	28×20,	,,	38/6
,,	20×10,	,,	27/9
,,	18¾×14,	,,	19/7½
I.X.		,	44/6
I.X.X.		,,	51/6
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	17/-
,,	28×20,	,,	33/9
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Terneplates,	28×20,	,,	34/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Aug. 30	62	17	6	inc.	7/6
,, 31	62	15	0	dec.	2/6
Sept. 1	63	2	6	inc.	7/6
,, 4	63	2	6	No change	
,, 5	63	0	0	dec.	2/6

Electrolytic Copper.

Aug. 30	69	0	0	inc.	5/-
,, 31	69	5	0	,,	5/-
Sept. 1	69	10	0	,,	5/-
,, 4	70	0	0	,,	10/-
,, 5	70	5	0	,,	5/-

Standard Tin (cash).

Aug. 30	160	7	6	inc.	17/6
,, 31	160	10	0	,,	2/6
Sept. 1	160	17	6	,,	7/6
,, 4	159	12	6	dec.	25/-
,, 5	159	10	0	,,	2/6

Tin (English ingots)

Aug. 30	159	17	6	inc.	17/6
Aug. 31	160	0	0	inc.	2/6
Sept. 1	160	10	0	,,	10/-
,, 4	159	2	6	dec.	27/6
,, 5	159	0	0	,,	2/6

Zinc Sheets (English).

Aug. 30	37	0	0	No change
,, 31	37	0	0	,,
Sept. 1	37	0	0	,,
,, 4	37	0	0	,,
,, 5	37	10	0	inc. 10/-

Spelter (ordinary).

Aug. 30	30	17	6	dec.	2/6
,, 31	30	17	6	No change	
Sept. 1	31	2	6	inc.	5/-
,, 4	31	7	6	,,	5/-
,, 5	31	5	0	dec.	2/6

Lead (English).

Aug. 30	25	10	0	No change
,, 31	25	10	0	,,
Sept. 1	25	10	0	,,
,, 4	25	10	0	,,
,, 5	25	10	0	,,

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
STOURBRIDGE, ENGLAND.

Manufacturers of
FIRE BRICKS, BLAST FURNACE BRICKS & CUPOLA BRICKS.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London: 10, Bush Lane, Cannon St, E.C.4.
Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.
Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.
BEST H. C. COPPER & BRONZE WIRE a speciality.
Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
18, BENNETTS HILL, BIRMINGHAM.
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5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.
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SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

INDIAN REPRESENTATION.

SCOTCHMAN, with 14 years' COMMERCIAL EXPERIENCE IN INDIA, open to negotiate with Iron and Steel, Paint and Varnish, Engineer and Small Tool, Agricultural Tool, Brassfoundry, Cutlery, Hardware, Manufacturing and Exporting Firms, with a view to representation in India. Keen worker. Splendid References. Apply, "A.R.A.," c/o FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOREMAN MOULDER WANTED AT ONCE in S. Wales district; he must be thoroughly experienced in the rapid production of steel, iron, and brass castings, expert knowledge of machine moulding and pattern plates essential, and able to control a large number of men. State age, experience, and salary required. Apply, Box 244, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

REQUIRED FOR INDIA. Experienced Iron Foundry Foreman, must be I.B.F. man. Apply, Box No. E.D., Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C.2.

WANTED.—HIGHLY CAPABLE FOREMAN for GENERAL IRONFOUNDRY of 100 hands. (Castings ½ to 10 tons.) Must be keen to a degree in economical production of non-repetition work, and up-to-date both practically and theoretically in every detail of foundry practice. Estimating and diplomatic handling of employees necessary. State age (not over 38), positions held, periods and employers, also salary required, to Box 248, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C. 2.

TENDERS.

RENFREW.

IRON FOUNDRY AND SMELTING WORKS FOR SALE.

FOR SALE, the IRON FOUNDRY and SMELTING WORKS belonging to A. MACAULAY & COMPANY, LIMITED, RENFREW, now in Liquidation :—

1. The Iron Foundry, having a frontage to Brown Street, Renfrew, consists of :—
   Main Foundry Building, Mechanics' Shop, Dressers' Shed, Bogie Rail Track, Plant and Machinery, etc. Electric Light Installation.
   Extent of ground, 1 acre or thereby. Feu duty, £23 0s. 5d. Casualties redeemed.
2. The Smelting Works, having a frontage to French Street, Renfrew, of about 162 feet, consist of :—
   Main Building forming Smelting Works, Melting Furnaces, Plant and Machinery, Offices, Store, Washhouse, Petrol Store and Tanks.
   Extent of ground, 1 acre, 2 poles, 19 square yards, or thereby. Feu duty, £18 17s. 6d. Casualties redeemed.

Offers marked "Tenders for Macaulay's Iron Foundry and Smelting Works" are invited for both Works, or for each Work separately, and should be lodged with the Liquidator, R. H. Ballantine, C.A., 116, Hope Street, Glasgow, not later than Wednesday, September 27, 1922.

For further particulars and cards to view, apply to J. Wyllie Guild and Ballantine, C.A., 116, Hope Street, Glasgow, or to Anderson Fyfe Littlejohn & Company, Solicitors, 201, West George Street, Glasgow.

TENDERS (*continued*).

GALVANISED Iron or Steel Tubular Poles for Telegraph Poles, 20 ft. long, 1,500, Schedule 755. Tenders are invited by the Commonwealth of Australia for the above, receivable in Australia on 15th November.—For tender, forms, and full particulars, apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining.

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY
known as
"THE BARTON SEAGRAVE ESTATE,"
lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about
854 ACRES, with the
VALUABLE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

MACHINERY.

FOR SALE.

Two new Thompson Dish-ended Lancashire Boilers, 30 ft. x 8 ft. 3 in., for 150 lbs. pressure. Three Lancashire Boilers, 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Two Cornish Boilers, 28 ft. x 6 ft. diameter, reinsure 90 lbs. pressure. Four Marine Water Tube Boilers, by Yarrow, Limited, each 4,000 sq. ft. heating surface, reinsure 200 lbs. pressure. One Loco Type Boiler, barrel 7 ft. 6 in. long x 3 ft. diameter, reinsure 80 lbs. pressure. One Vertical Boiler, 6 ft. 6 in. x 3 ft. 9 in. diameter, reinsure 80 lbs. pressure. One Hornsby Waste Heat Water Tube Boiler, about 40 h.p., reinsure 160 lbs. pressure. Air Receivers, 6 ft. x 2 ft. 6 in., tested to 90 lbs. pressure, with safety valve, drain cock, etc.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

FOR SALE.—TIPPING TYPE CRUCIBLE FURNACE by GREEN, 400-lbs. capacity, complete with fan. Particulars and price from Hoe, 109, Borough Road, London, S.E.1.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

(*Continued on page* 206.)

CUPOLAS

30-in. ALLDAY'S CUPOLA with hoist, staging, 20ft. by 10ft. and roof, complete installation £150 f.o.r., standing in London.

42-in. WHITING CUPOLA, with spark arrester, staging hoist, etc., ready for immediate use, and complete in every detail, £380 f.o.r. London, for the entire plant, including 3 phase, 50 cycle, 415 volt electric hoist, and electric blower, same voltage.

URGENTLY REQUIRED

2-ton stock oil-fired converter. Two small tilting cupolettes. Also **all kinds** of surplus foundry plant **for re-sale.** Please send offers to—

ALEXANDER HAMMOND,
Foundry Machinery Merchant,
"BOXTED," SLOUGH.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

You Get Exceptional Efficiency, Economy and Service when you use our—

LADLES

Our standard line includes Pressed Steel **Shank Ladles, Swivel Tilting, Bogie,** Ungeared, Geared and **Bottom Pouring Steel Ladles.** Capacities from 28lbs. to 20 tons. Ample safety margin is allowed in all strengths.

Geared Ladles carry our improved worm type gearing, fitted with gear covers. Bail of Crane Ladles, 10 cwt. to 10 ton capacity, is of **improved pressed Steel Section with adjustable shackle,** as illustrated, giving ample strength combined with lightness. Note also **slag skimming device.**—We also manufacture **Improved Rapid Melting Cupolas** of any size, **Charging Devices and Platforms,** etc. We Build and completely Equip Foundries all over the world. Constructural Steel Work of every description.

May we send you full details.

Contractors to British, French and Belgian Governments.

The Constructional Engineering Co. Ltd.

Titan Works
Charles Henry Street, Birmingham, England.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	2	6
Three months	63	10	0
Electrolytic	70	15	0
Tough	65	15	0
Best selected	65	15	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	0	0
Do. Oct.	71	0	0
Do. Nov.	71	0	0
Ingot bars	71	0	0
H.C. wire rods	76	5	0
Off. aver. cash, Aug.	63	16	9 8/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 3/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug.	67	6	8
Aver. spot price, copper, Aug.	63	16	1¼
Do. Electro, Aug.	70	18	7½

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13¼d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes 13¼d
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

Standard cash	158	12	6
Three Months	159	10	0
English	158	0	0
Bars	160	0	0
Chinese	157	2	6
Straits	159	2	6
Australian	159	15	0
Eastern	161	15	0
Banca	158	15	0
Off. aver., cash, Aug.	160	1	0 3/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Sttlment. Aug.	160	1	7 1/11
Aver. spot, Aug.	160	0	5½

SPELTER.

Ordinary	31	10	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	34	7	6
English	31	15	0
India	24	0	0
Prime Western	31	12	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., Aug.	30	16	3
Aver., spot, Aug.	31	3	5

LEAD.

Soft foreign ppt	24	10	0
English	25	10	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	15	0

QUICKSILVER.

Quicksilver 12 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 5 0
75% 21 10 0

Ferro-vanadium—
35/40% 17/6 lb. va.

Ferro-molybdenum—
70/75% 7/9 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/6 lb.

Tungsten metal powder—
98/99% .. .. 1/9½ lb.

Ferro-chrome—
4/6% car. £23 0
6/8% car. £22 10
8/10% car. .. £22 0

Ferro-chrome—
Max. 2% car. .. £60
Max. 1% car. .. £68
Max. 0.70% car. .. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 11/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb.

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	0	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries		4	0	0		

Cleveland—
Heavy steel .. 3 5 0
Steel turnings .. 2 8 6
Cast-iron borings 2 8 6
Heavy forge .. 3 12 6
Bushelled scrap .. 2 12 6
Cast-iron scrap .. 3 12 6

Lancashire—
Cast iron scrap .. 3 17 6
Heavy wrought .. 3 7 6
Steel turnings .. 2 2 6

London— £ s. d.
Copper (clean) .. 56 0 0
Brass (clean) .. 30 0 0
Lead (less usual draft) 21 0 0
Tea lead 18 0 0
Zinc 17 0 0
New aluminium cuttings .. 60 0 0
Braziery copper .. 46 0 0
Gun metal .. 40 0 0
Hollow pewter .. 125 0 0
Shaped black pewter 80 0 0
Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—
Foundry No. 1 .. 97/6
Foundry No. 3 .. 90/-
Forge No. 4 .. .. 87/6
Mottled 81/-
Hematite No. 1 .. 90/6
Hematite M/Nos. .. 90/-
Midlands—
Staffs. common .. —
,, part-mine forge —
,, ,, foundry —
,, Cold blast .. 240/-
,, basic .. .. —
Northants forge 70/- to 72/6
,,foundry No. 3 77/6 ,, 80/-
,, basic 82/6
Derbyshire forge .. 75/-
,, foundry No. 3 82/6
,, basic .. 80/-
Scotland—
Foundry No. 1 .. 106/6
,, No. 3 . 101/6
Hematite M/Nos. .. 107/6
Sheffield (d/d district)—
Derby forge 82/6
,, foundry No. 3 86/6
,, basic .. .. —
Lincs. forge 86/6
,, foundry No. 3 86/6
,, basic 86/6
E.C. hematite .. 101/-
W.C. hematite .. 102/6
All d/d in the district.
Lancashire (d/d eq. Man.) —
Derby forge .. .. —
,, foundry No. 3 92/6
Northants foundry No. 3 .. .. —
Cleveland foundry No. 3 .. .. —
Staffs. foundry No. 3 —
Lincs. forge .. .. —
,, foundry No. 3 —
Summerlee foundry .. 116/6
Glengarnock foundry 118/6
Gartsherrie foundry 118/6
Monkland fouudry .. 116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles ..	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt ..	9	17	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip ..	11	0	0
Bolts and nuts, ⅞ in. × 4 in.	18	10	0

Steel—
Ship plates £9 to 9 10 0
Boiler plates .. 12 10 0
Chequer plates 10 10 0
Angles £8 12 6 to 8 17 6
Tees £9 12 6 to 9 17 6
Channels .. 8 10 0
Joists 9 0 0
Rounds & squares 3-in. to 5½in. .. 10 0 0
Rounds, under 3in. to ⅞in. .. 9 10 0
Flats, over 5in. wide and up .. 10 0 0
Flats 5in. to 1½in. 8 10 0

	£	s.	d.
Rails, heavy ..	8	15	0
Fishplates ..	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ½ in. dia	13	0	0
Billets, soft 7 0 0 to 7	5	0	
Billets, hard ..	8	0	0
Sheet bars 6 17 6 to 7	7	6	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2⅝
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire round—	
3/0 to 10. G. ..	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.14
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	23.00
Basic	31.96
Bessemer	33.76
Malleable	34.96
Grey forge	34.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars ..	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.75
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv. ..	3.15
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry .. 35/- to 40/-
,, furnace .. 30/- to 32/6
Durham & North. foundry 28/-
,, furnace .. 23/6
Other Districts, foundry 27/6
,, furnace 22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C. Cokes,	20×14, box		19/3
,,	28×20,	,,	38/6
,,	20×10,	,,	28/-
,,	18¾×14,	,,	19/7½
I.X.		,,	44/-
I.X.X.		,,	51/-
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	17/-
,,	28×20,	,,	33/9
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Ternepiates,	28×20,	,,	34/3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Sept. 6	63	0	0	No change
,, 7	63	2	6	inc. 2/6
,, 8	63	2	6	No change
,, 11	63	0	0	dec. 2/6
,, 12	63	2	6	inc. 2/6

Electrolytic Copper.

Sept. 6	70	10	0	inc. 5/-
,, 7	70	10	0	No change
,, 8	70	15	0	inc. 5/-
,, 11	70	15	0	No change
,, 12	70	15	0	,,

Standard Tin (cash).

Sept. 6	159	10	0	No change
,, 7	159	15	0	inc. 5/-
,, 8	159	12	6	dec. 2/6
,, 11	159	5	0	,, 7/6
,, 12	158	12	6	,, 12/6

Tin (English ingots)

Sept. 6	159	0	0	No change
,, 7	159	5	0	inc. 5/-
,, 8	159	2	6	dec. 2/6
,, 11	158	15	0	,, 7/6
,, 12	158	0	0	,, 15/

Zinc Sheets (English)

Sept. 6	37	10	0	No change
,, 7	37	10	0	,,
,, 8	37	10	0	,,
,, 11	37	10	0	,,
,, 12	37	10	0	,,

Spelter (ordinary).

Sept. 6	31	7	6	inc. 2/6
,, 7	31	7	6	No change
,, 8	31	10	0	inc. 2/6
,, 11	31	10	0	No change
,, 12	31	10	0	,,

Lead (English).

Sept. 6	25	10	0	No change
,, 7	25	10	0	,,
,, 8	25	10	0	,,
,, 11	25	10	0	,,
,, 12	25	10	0	,,

We manufacture and can supply immediately

LOW GRADE

FERRO SILICON

8/10% 10/12% 12/15% and 20/25%.

THE NEWCASTLE ALLOY CO., LTD.,
Milburn House,
Newcastle-on-Tyne.

Telephone: 800 CITY (7 lines).
Telegrams: ALLOY, NEWCASTLE-ON-TYNE.

GIVE THE BRITISH MANUFACTURER FIRST CHANCE.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN for Iron Foundry (Herts), employing 40 hands. High-class General Castings (medium weight). Applicants must have held similar position and possess sound references as to organising ability and economic working.—State age and wages required to Box 250, Offices of THE FOUNDRY TRADE JOURNAL, 5, Duke Street, Adelphi, London, W.C.2.

TENDERS.

RENFREW.

IRON FOUNDRY AND SMELTING WORKS FOR SALE.

FOR SALE, the IRON FOUNDRY and SMELTING WORKS belonging to A. MACAULAY & COMPANY, LIMITED, RENFREW, now in Liquidation :—

1. The Iron Foundry, having a frontage to Brown Street, Renfrew, consists of :—
   Main Foundry Building, Mechanics' Shop, Dressers' Shed, Bogie Rail Track, Plant and Machinery, etc. Electric Light Installation.
   Extent of ground, 1 acre or thereby. Feu duty, £23 0s. 5d. Casualties redeemed.
2. The Smelting Works, having a frontage to French Street, Renfrew, of about 162 feet, consist of :—
   Main Building forming Smelting Works, Melting Furnaces, Plant and Machinery, Offices, Store, Washhouse, Petrol Store and Tanks.
   Extent of ground, 1 acre, 2 poles, 19 square yards, or thereby. Feu duty, £18 17s. 6d. Casualties redeemed.

Offers marked "Tenders for Macaulay's Iron Foundry and Smelting Works" are invited for both Works, or for each Work separately, and should be lodged with the Liquidator, R. H. Ballantine, C.A., 116, Hope Street, Glasgow, not later than Wednesday, September 27, 1922.

For further particulars and cards to view, apply to J. Wyllie Guild and Ballantine, C.A., 116, Hope Street, Glasgow, or to Anderson Fyfe Littlejohn & Company, Solicitors, 201, West George Street, Glasgow.

CITY OF HULL

TRAMWAY RAILS.

The Corporation are prepared to receive Tenders for the supply of 500 or 1,000 Tons TRAMWAY RAILS, 112 lbs. to the yard, Hull section (centre groove), together with 30 Tons FISHPLATES.

Also for the purchase of about 300 Tons OLD RAILS, to be taken up during the ensuing six months

Forms of Tender and other particulars may be obtained of the undersigned.

Forms for the supply of Rails will only be furnished to actual manufacturers or their accredited agents.

Tenders, endorsed as directed on the Forms of Tender, are to be addressed to the Chairman of the Tramways Sub-Committee and delivered at the Town Clerk's Office before noon on WEDNESDAY, the 27th September.

The Corporation do not bind themselves to accept any Tender.

By Order,
F. W. BRICKNELL,
City Engineer.

31st August, 1922.

GALVANISED Iron or Steel Tubular Poles for Telegraph Poles, 20 ft. long, 1,500, Schedule 755. Tenders are invited by the Commonwealth of Australia for the above, receivable in Australia on 15th November.—For tender, forms, and full particulars, apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

TENDERS (*continued*).

NATIONAL GAS COUNCIL OF GREAT BRITAIN AND IRELAND.

Gas Cooking Stoves.

FOR the purpose of enabling Standard Cookers, manufactured according to specifications approved by the National Gas Council, to be purchased by the Gas Industry, the Council is prepared to receive tenders for the supply of the following :—

(1) One set of lead master patterns for each of two sizes of stove, viz., No. 2 (unpacked) and No. 3 (packed), in accordance with drawings and specifications to be supplied by the Council.

(2) Sets of original Cast Iron patterns for each size of stove.

(3) One set of master jigs for each size of stove.

(4) 12 specimen cookers of each of the above sizes in accordance with drawings and specifications to be supplied by the Council.

(5) Complete Base Stands (two sizes, viz., 4 in. and 24 in. high) in accordance with drawings and specifications to be supplied by the Council.

(6) One set of lead master patterns for each size of stand.

(7) Sets of Cast Iron patterns for each size of stand.

(8) Complete plate racks (including back plate) in accordance with drawings to be supplied by the manufacturer and to the general specification of the Council.

NOTE.—To enable them to adjudicate between the different tenders submitted, the Council reserve to themselves the right to require detailed working drawings of all the above patterns and jigs, if they think fit.

Firms willing and able to supply are invited to apply in writing as soon as possible, but in any event not later than October 4, 1922, to the undersigned, for the necessary drawings, specifications, forms of tender and of contract conditions, which will be forwarded upon payment of a fee of £25, which fee will be returned in cases where a bonâ fide tender is duly made.

The Council does not bind itself to accept the lowest or any tender

W. J. SMITH,
Secretary.

NATIONAL GAS COUNCIL OF GT. BRITAIN AND IRELAND,
30, Grosvenor Gardens, London, S.W.1.
September 11, 1922.

MACHINERY.

FOR SALE.—One No. 6 Thwaites Rapid Cupola, with drop bottom, complete with charging and cleaning doors in new condition, equal in every respect to new.—Price, £125, f.o.r., Keighley.

Two No. 6 Keith Blackman High Pressure Motor-driven Fans, complete with starters, etc, suitable for 400 volts, 50 periods, 65 amps., 12-in. delivery, 3-phase A.C.—Price, £125 each, f.o.r., Keighley.—Apply, Box 246, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

CUPOLAS

30-in. ALLDAY'S CUPOLA with hoist, staging, 20ft. by 10ft. and roof, complete installation £150 f.o.r., standing in London.

42-in. WHITING CUPOLA, with spark arrester, staging hoist, etc., ready for immediate use, and complete in every detail, £380 f.o.r. London, for the entire plant, including 3 phase, 50 cycle, 415 volt electric hoist, and electric blower, same voltage.

URGENTLY REQUIRED

2-ton stock oil-fired converter. Two small tilting cupolettes. Also **all kinds** of surplus foundry plant **for re-sale.** Please send offers to—

ALEXANDER HAMMOND,
Foundry Machinery Merchant,
"BOXTED," SLOUGH.

Small Advertisements continued on page 228.

Telegrams: "THROWER, GLASGOW." Telephone: 5909 CENTRAL.

ALBERT SMITH & Co FOUNDRY ENGINEERS. TOOLS & EQUIPMENT

Head Office: 60, St. ENOCH SQUARE, GLASGOW.

SAND BLAST EQUIPMENT. For any Service.

MOULDING MACHINES. Electric, Air and Hand Power.

FORCED DRAUGHT. Core Stove, Furnaces.

PORTABLE CORE OVENS.

CORE MACHINES. Core Compound. Core Oil. Glutrin. Parting Powder. Perforated Chaplets, &c.

BRASS RECOVERY MACHINES. New Process.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, France-British Grand Prix (Highest Award) 1908.

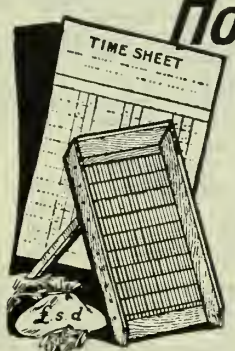
CUPOLAS

No. 1 GREEN'S CUPOLETTE, with 480 volt D.C. blower £40
2 ft. 6 in. ALLDAY'S CUPOLA, with belt-driven fan .. £60
3 ft. 6 in. WHITING CUPOLA, with spark arrester, as new £95
(Charging stage, hoist, and blower, to suit are in stock.)
2½-ton EVANS' CRANE LADLE, as new £35
EVANS' ½-ton CRANE LADLE, not geared, new .. £14
HAND LADLES and SHANKS, every size from 30 lbs. to 4 cwt. in stock, new and secondhand, **CHEAP.**
30 MOULDING MACHINES in stock, all types.
800 PAIRS OF MOULDING BOXES in stock, all standard and interchangeable, sizes as below:—

18" × 18", 5" tops, 5" bottoms,	18 – pair	150 pairs in stock
16" × 14", 4½" ,, 4½" ,,	16 – ,,	250 ,, ,,
18" × 12", 4" ,, 4" ,,	12 – ,,	200 ,, ,,
15" × 10", 4" ,, 4" ,,	12 – ,,	60 pairs, (pressed and steel)
12" × 12", 4" ,, 4" ,,	10 – ,,	60 pairs.

I supply every item of foundry equipment, both new and secondhand; am prepared to design and instal Foundry Plants Complete.

ALEXANDER HAMMOND,
Foundry Machinery Merchant.
"BOXTED," SLOUGH.



How many Hours wasted daily?
-through bad Screening

WIRE screens are traps for material that clog continually, waste men's time and make a hole in your profits. You cannot afford this. Instal at once an

EXCELSIOR Steel Bladed SCREEN

that really *cuts* and screens—evenly and speedily. Blades taper from front to rear, ensuring clear drop and no sticking. Lasts indefinitely—never needs clearing. We guarantee EXCELSIOR SCREEN 12 months against faulty workmanship or defects due to ordinary wear and tear.

Write to-day for List E.S. 71/2 with specially reduced prices.

Parker, Winder & Achurch Ltd.
BROAD STREET, BIRMINGHAM.

London: 40, Craven St., Strand, W.C.2.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	12	6
Three months.. ..	63	5	0
Electrolytic	71	5	0
Tough	65	15	0
Best selected	65	15	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	10	0
Do. Oct.	71	10	0
Do. Nov.	71	10	0
Ingot bars	71	7	6
H.C. wire rods.. ..	76	12	6
Off. aver. cash, Aug.	63	16	$9\frac{9}{11}$
Do. 3 mths., Aug.	63	19	$2\frac{5}{11}$
Do. Settlement Aug.	63	16	$11\frac{2}{11}$
Do. Electro, Aug.	70	8	$7\frac{7}{11}$
Do. B.S., Aug. ..	67	6	8
Aver. spot price, copper, Aug. ..	63	16	$1\frac{1}{2}$
Do. Electro, Aug.	70	18	$7\frac{1}{2}$

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods.. 6½d.
Do. 4x4 Sqnares .. 8½d.
Do. 4x3 Sheets .. 9¼d

BRASS.

Solid drawn tubes.. 11¾d.
Brazed tubes 13½d
Rods, drawn .. .. 10⅝d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9½d.
Rolled metal .. 9½d.

TIN.

Standard cash ..	158	15	0
Three Months ..	159	17	6
English	158	5	0
Bars	160	5	0
Chinese	157	5	0
Straits	159	0	0
Australian	159	0	0
Eastern	161	5	0
Banca	158	17	6
Off. aver ,cash, Aug.	160	1	$0\frac{3}{11}$
Do. 3 mths., Aug.	160	3	$4\frac{10}{11}$
Do. Sttlment. Aug.	160	1	$7\frac{1}{11}$
Aver. spot, Aug...	160	0	$5\frac{1}{2}$

SPELTER.

Ordinary	31	12	6
Remelted	30	0	0
Hard	24	0	0
Electro 99.9	34	10	0
English	31	15	0
India	24	10	0
Prime Western ..	31	15	0
Zinc dust	48	0	0
Zinc ashes	9	10	0
Off. aver., Aug. ..	30	16	3
Aver., spot, Aug. ..	31	3	5

LEAD.

Soft foreign ppt ..	24	7	6
English..	25	5	0
Off. average, Aug.	24	3	$10\frac{4}{11}$
Average spot, Aug.	24	11	$8\frac{1}{2}$

ZINC SHEETS.

Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates ..	36	0	0

ANTIMONY.

English regulus ..	25	15	0
Special brands ..	32	10	0
Chinese	23	10	0
Crude	14	15	0

QUICKSILVER.

Quicksilver 13 7 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
15/50% 12 5 0
75% 21 0 0
Ferro-vanadium—
35/40% 17/6 lb. va.
Ferro-molybdenum—
70/75% 8/9 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/1½ lb.
Ferro-phosphorus, 20/23%, £26
Ferro-tungsten—
80/85%, carbon free 1/6 lb.
Tungsten metal powder—
98/99% .. .. 1/9½ lb.
Ferro-chrome—
4/6% car. £32 0
6/8% car. £22 10
8/10% car. .. £22 0
Ferro-chrome—
Max. 2% car. .. £55
Max. 1% car. .. £68
Max. 0.70% car. .. £75
67/70%, carbonless 1/6½ lb.
Nickel—99%, cubes or pellets £150
Cobalt metal—98/99% 12/- lb.
Aluminium—98/99% £100
Metallic Chromium—
96/98% .. .. 5/- lb.
Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	0	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries		4	0	0		
Cleveland—						
Heavy steel		3	2	6		
Steel turnings		2	9	6		
Cast-iron borings		2	9	6		
Heavy forge		3	12	6		
Bushelled scrap		2	12	6		
Cast-iron scrap		3	12	6		
Lancashire—						
Cast iron scrap		3	17	6		
Heavy wrought		3	7	6		
Steel turnings		2	2	6		

London—	£	s.	d.
Copper (clean) ..	56	0	0
Brass (clean) ..	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	18	0	0
Zinc	17	0	0
New aluminium cuttings ..	60	0	0
Braziery copper ..	46	0	0
Gun metal ..	40	0	0
Hollow pewter ..	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1 ..	97.6
Foundry No. 3 ..	95/-
Forge No. 4	85/-
Mottled	82/-
Hematite No. 1 ..	90/6
Hematite M/Nos. ..	90/-
Midlands—	
Staffs. common ..	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast ..	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic.. ..	82/6
Derbyshire forge ..	75/-
,, foundry No. 3	82/6
,, basic ..	80/-
Scotland—	
Foundry No. 1 ..	106/6
,, No. 3 ..	101/6
Hematite M/Nos. ..	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite ..	101/-
W.C. hematite ..	102/6

All d/d in the district.

Lancashire (d/d eq. Man.)	
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry..	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry ..	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.) £10 15 to 11	10	0	
Angles £11 5 to 11	10	0	
Tees to 3 united ins. £11 15 to	12	5	0
Nut and bolt ..	9	17	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip ..	11	0	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0
Steel—			
Ship plates £9 to	9	10	0
Boiler plates ..	12	10	0
Chequer plates	10	10	0
Angles £8 12 6 to	8	17	6
Tee £9 12 6 to	9	17	6
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in...	10	0	0
Rounds, under 3in. to ⅜in. ..	9	10	0
Flats, over 5in. wide and up..	10	0	0
Flats 5in. to 1¼in.	8	10	0

	£	s.	d.
Rails, heavy ..	8	15	0
Fishplates ..	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ¾ in. dia	12	15	0
Billets, soft 7 0 0 to	7	2	6
Billets, hard ..	8	0	0
Sheet bars	6 17 6 to	7	7 6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire round— 3/0 to 10. G. ..	1/8½ to 2/3½

with extras according to gange

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.14
No. 2 foundry Valley..	33.00
No. 2 foundry, Birm. ..	23.00
Basic	31.96
Bessemer	33.76
Malleable	34.96
Grey forge	34.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars ..	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.75
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv. ..	3.15
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry ..	35/- to 40/-
,, furnace ..	30/- to 32/6
Durham & North. foundry	28/-
,, furnace ..	23/6
Other Districts, fonndry	27/6
,, furnace	22/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £ 17 s. 0 d. 0 to

Nail Rods— Square, round and flats .. 17 10 0

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms— Single welded .. £10 to £11

Billets— Single and double welded £13 to £14

Pig-Iron— Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

		Up to and incl. 6 in.
Gas	..	55%
Water	..	50%
Steam	..	45%

Tube prices are now free.

TINPLATES.

I.C. Cokes,	20×14, box		19/1½
,,	28×20,	,,	38/3
,,	20×10,	,,	28/-
,,	18¾×14,	,,	19/6
I.X.		,	44/-
I.X.X.		,,	51/-
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	16 10½
,,	28×20,	,,	33/6
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Terneplates,	28×20.	,,	34/3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Sept.13	63	5	0	inc.	2 6
,, 14	63	7	6	,,	2/6
,, 15	63	2	6	dec.	5/-
,, 18	62	17	6	,,	5/-
,, 19	62	12	6	dec.	5/-

Electrolytic Copper.

Sept.13	71	0	0	inc.	5/-
,, 14	71	10	0	,,	10/-
,, 15	71	10	0	No change	
,, 18	71	10	0	,,	
,, 19	70	10	0	,,	

Standard Tin (cash).

Sept.13	159	2	6	inc.	10/-
,, 14	159	10	0	inc.	7/6
,, 15	159	2	6	dec.	7/6
,, 18	159	0	0	,,	2/6
,, 19	158	15	0	,,	5/-

Tin (English ingots)

Sept.13	158	10	0	inc.	10/-
,, 14	159	0	0	inc.	10/-
,, 15	158	12	6	dec.	7/6
,, 18	158	10	0	,,	2/6
,, 19	158	5	0	,,	5/-

Zinc Sheets (English).

Sept.13	37	10	0	No change
,, 14	37	10	0	,,
,, 15	37	10	0	,,
,, 18	37	10	0	,,
,, 19	37	10	0	,,

Spelter (ordinary).

Sept.13	31	12	6	inc.	2/6
,, 14	31	12	6	No change	
,, 15	31	12	6	,,	
,, 18	31	12	6	,,	
,, 19	31	12	6	,,	

Lead (English)

Sept.13	25	5	0	dec.	5/-
,, 14	25	5	0	No change	
,, 15	25	5	0	,,	
,, 18	25	5	0	,,	
,, 19	25	5	0	,,	

There's something for You among these

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

IRON & STEEL SCRAP

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN FOREMAN, 7 years U.S.A., expert knowledge and supervisory ability; competent to take charge of any shop. A1 references, desires situation.—Address, Box 254, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN, South Wales, wants situation in North of England or London district; thoroughly experienced in Ship Repairing, Hydraulic, and General Engineering Castings; good references for ability and character.—Address, "STABILITY," Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.

FOR SALE.

Two Davey Paxman Economic Boilers, each 14 ft. x 8 ft. for 160 lbs. working pressure, and two ditto 180 lbs. working pressure. Three Lancashire Boilers, 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Two Marine Boilers, 10 ft. 4 in. x 12 ft. 2 in. diameter, reinsure 150 lbs. pressure. Nine nearly-new Loco Type Boilers, 10 N.H.P., reinsurable 150 lbs. working pressure. "Galloway" Boiler, 24 ft. x 6 ft. 8 in. diameter, reinsure 100 lbs. pressure. Several hundreds of Tanks, rectangular and circular, 10 gallons capacity upwards. Several Dishended Cylinders, each 6 ft. x 2 ft., tested hydraulically to 150 lbs. pressure.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

WANTED.—One Foundry Ladle only, 10 cwts. capacity, and complete with slings.—Reply, Box 252, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CUPOLA, new, Thwaites No. 6 Rapid, capacity 5-6 tons per hour, with all improvements, f.o.r. Dudbridge, near Stroud. BLOWER, "Acme" (new) by Samuelson & Company, Limited, (exclusive motor), Brookhirst motor starting panel wall mounting, suitable for starting motor against full load, torque frequently; suitable for the above Cupola; f.o.r. Dudbridge, near Stroud. Reasonable offer accepted.—Box 256, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY —*Contd.*

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

FOR SALE.—One No. 6 Thwaites Rapid Cupola, with drop bottom, complete with charging and cleaning doors in new condition, equal in every respect to new.—Price, £125, f.o.r., Keighley.

Two No. 6 Keith Blackman High Pressure Motor-driven Fans, complete with starters, etc, suitable for 400 volts, 50 periods, 65 amps., 12-in. delivery, 3-phase A.C.—Price, £125 each, f.o.r., Keighley.—Apply, Box 246, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

PATENTS.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE Proprietor of British Patent No. 147,925, dated September 11, 1918, relating to Improvements in Pair-heating-Furnace Hearth, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. All inquiries to be addressed to MR. B. SINGER, Woolworth Building, New York City, N.Y., U.S.A

THE Owner of British Patents 23719/13 and 105075, relating to an improved process of casting ingots of metals and alloys and apparatus therefor, is desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above inventions either by sale of the patent rights or by the grant of a licence or licences to manufacture under Royalty.—Inquiries should be addressed to MESSRS. ABEL & IMRAY, Chartered Patent Agents, 30, Southampton Buildings, London, W.C.2.

PATENTS AND DESIGNS ACTS, 1907 and 1919.
CASTINGS.

THE Proprietors of British Letters Patent No. 145,078 are prepared to sell the Patent or to license British manufacturers to work under it. It relates to improvements in the production of solid or hollow metallic castings of various forms by centrifugal action in vertical moulds.

Address :—B.W. & T.,
111/112, Hatton Garden,
London, E.C.1.

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FOR SALE.—FREEHOLD FOUNDRY (Ferrous and Non-Ferrous).—Apply, E. T. PEIRSON & SONS, Chartered Accountants, Coventry.

MISCELLANEOUS.

SCIENTIFIC FACTS
for foundrymen and manufacturers

An exact knowlege concerning the properties and qualities of the various materials you use will probably enable you to effect lasting economies in more than one direction, and to overcome many difficulties of production. We place at your disposal an expert staff and complete facilities for the

TESTING, ANALYSING AND CONSULTING

on Iron, Steel, Non-ferrous Alloys, Sands, Fuels, and materials of every description. Our services extend to Chemical Analysis, Mechanical Testing on machines approved by the Board of Trade, and Metallurgical Consulting in all branches of Foundry work, including Mouldings, Cores, Mixing of Metals, etc., etc.

Let us help on *your* problems! Write us to-day for terms.

BEECROFT & PARTNERS, Ltd.
MANAGING DIRECTOR, F. J. BEECROFT
(*Over 40 years' actual foundry and metallurgical experience*),
St. Peter's Close, Sheffield.
'Phone: Sheffield 1582. *'Grams*: "Retort, Sheffield."
Code: A.B.C., 5th Edition.
ALSO AT **Norfolk House, Cannon Street, Birmingham.**

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ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

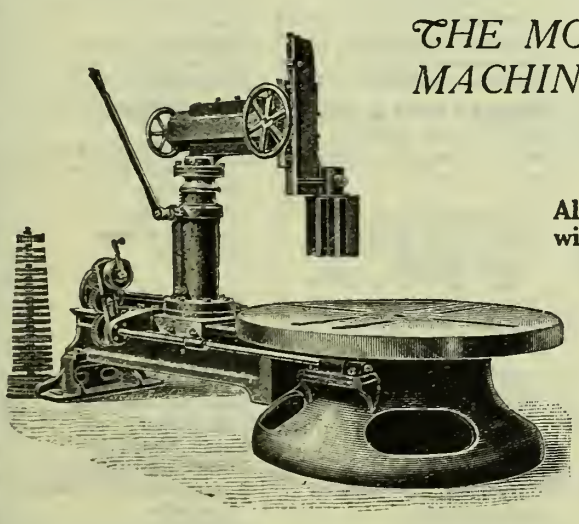
FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 feet diameter can be made.



THE MOST COMPLETE & EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WILLIAM WHITTAKER & SONS, Ltd.

SUN IRON WORKS - - - OLDHAM.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	2	6
Three months	63	15	0
Electrolytic	71	5	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	5	0
Do. Oct.	71	5	0
Do. Nov.	71	0	0
Ingot bars	71	0	0
H.C. wire rods	76	7	6
Off. aver. cash, Aug.	63	16	9 1/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 2/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug. ..	67	6	8
Aver. spot price, copper, Aug. ..	63	16	1¾
Do. Electro, Aug.	70	18	7½
Solid drawn tubes ..			13¾d.
Brazed tubes			13¾d.
Wire			10½d.
Yellow metal rods ..			6¾d.
Do. 4x4 Squares ..			8¼d.
Do. 4x3 Sheets ..			9¼d.

BRASS.

Solid drawn tubes ..	11¾d
Brazed tubes	13¾d
Rods, drawn	10¾d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g. ..	10d.
Wire	9¾d.
Rolled metal ..	9¼d.

TIN.

	£	s	d.
Standard cash ..	161	5	0
Three Months ..	162	10	0
English	161	5	0
Bars	163	5	0
Chinese		—	
Straits	161	17	6
Australian	161	15	0
Eastern	164	2	6
Banca	161	12	6
Off. aver, cash, Aug.	160	1	0 3/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Sttlment. Aug.	160	1	7 1/11
Aver. spot, Aug. ..	160	0	5½

SPELTER.

	£	s	d.
Ordinary	32	5	0
Remelted	30	10	0
Hard	24	10	0
Electro 99.9	34	10	0
English	32	5	0
India	25	7	6
Prime Western ..	32	10	0
Zinc dust	48	0	0
Zinc ashes	10	10	0
Off. aver., Aug. ..	30	16	3
Aver., spot, Aug. ..	31	3	5

LEAD.

	£	s	d.
Soft foreign ppt ..	23	18	9
English	25	5	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates ..	36	0	0

ANTIMONY.

	£	s	d.
English regulus ..	25	15	0
Special brands ..	32	10	0
Chinese	23	10	0
Crude	15	0	0

QUICKSILVER.

	£	s	d.
Quicksilver	13	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s	d.
Ferro-silicon — 45/50% ..	12	2	6
75% ..	20	15	0
Ferro-vanadinm — 35/40%	17/3 lb. va.		
Ferro-molybdenum — 70/75%	8/6 lb. mo.		
Ferro-titaninm — 23/25%, carbonless	1/1 lb.		
Ferro-phosphorus, 20/23%, £27			
Ferro-tungsten — 80/85%, carbon free	1/5½ lb.		
Tungsten metal powder — 98/99%	2/– lb.		
Ferro-chrome — 4/6% car.	£23	0	
6/8% car. ..	£22	12	6
8/10% car. ..	£22	5	
Ferro-chrome — Max. 2% car. ..	£55		
Max. 1% car. ..	£68		
Max. 0.70% car. ..	£75		
67/70%, carbonless	1/6½ lb.		
Nickel — 99%, cubes or pellets	£145		
Cobalt metal — 98/99%	12/– lb.		
Aluminium — 98/99%	£100		
Metallic Chromium — 96/98%	5/– lb.		
Ferro-manganese (net) — 76/80%, loose ..	£15		
76/80%, packed ..	£16		
76/80%, export ..	£14	10	
Metallic manganese — 94/96%, carbonless	2/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras —
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel —
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales —	£	s.	d.	£	s.	d
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	0	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron ..	3	5	0	3	15	0
Good machinery for foundries ..		4	0	0		
Cleveland —						
Heavy steel ..		3	5	0		
Steel turnings ..		2	10	0		
Cast-iron borings		2	10	0		
Heavy forge ..		3	12	6		
Bushelled scrap ..		2	12	6		
Cast-iron scrap ..		3	10	0		
Lancashire —						
Cast iron scrap ..		3	17	6		
Heavy wrought ..		3	7	6		
Steel turnings ..		2	2	6		
London —	£	s.	d.			
Copper (clean) ..	56	0	0			
Brass (clean) ..	30	0	0			
Lead (less usual draft)	20	0	0			
Tea lead	17	0	0			
Zinc	17	0	0			
New aluminium cuttings ..	60	0	0			
Braziery copper ..	46	0	0			
Gun metal ..	40	0	0			
Hollow pewter ..	125	0	0			
Shaped black pewter	80	0	0			

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast —	
Foundry No. 1 ..	97 6
Foundry No. 3 ..	95/–
Forge No. 4	85/–
Mottled	82/6
Hematite No. 1 ..	89/6
Hematite M/Nos. ..	89/–
Midlands —	
Staffs. common ..	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast ..	240/–
„ basic	—
Northants forge 70/– to	72/6
„ foundry No. 3 77/6 „	80/–
„ basic	82/6
Derbyshire forge ..	75/–
„ foundry No. 3	82/6
„ basic ..	80/–
Scotland —	
Foundry No. 1 ..	106/6
„ No. 3 .	101/6
Hematite M/Nos. ..	107/6
Sheffield (d/d district) —	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite ..	100/–
W.C. hematite ..	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	90/–
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry ..	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry ..	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron —	£	s.	d.
Bars (cr.) £10 15 to	11	10	0
Angles £11 5 to	11	10	0
Tees to 3 united ins. £11 15 to	12	5	0
Nut and bolt ..	9	17	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip ..	11	0	0
Bolts and nuts, ⅝ in. × 4 in.	18	10	0
Steel —			
Ship plates £9 to	9	10	0
Boiler plates ..	12	10	0
Chequer plates	10	10	0
Angles £8 12 6 to	9	0	0
Tee £9 12 6 to	10	0	0
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in. ..	9	15	0
Rounds, under 3in. to ⅝in. ..	9	5	0
Flats, over 5in. wide and up ..	9	15	0
Flats 5in. to 1⅛in.	8	5	0
Rails, heavy ..	8	15	0
Fishplates ..	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ¾ in. dia	12	15	0
Billets, soft 7 0 0 to	7	2	6
Billets, hard ..	8	0	0
Sheet bars 6 17 6 to	7	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3¾
Wire	1 3½
Rods	1 2¼
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled —	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire round — 3/0 to 10. G. ..	1/8½ to 2/3

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.64
No. 2 foundry Valley ..	35.00
No. 2 foundry, Birm. ..	25.00
Basic	34.46
Bessemer	34.76
Malleable	34.96
Grey forge	36 76
Ferro-manganese 80 % delivered	75 00
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars ..	40.00
Wire rods	47.50
	Cents.
Iron bars, Phila. ..	2 57
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.75
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.35
Sheets, blue an'l'd, 9&10 .	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv. ..	3.15
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry ..	35/– to 40/–
„ furnace ..	30/– to 32/6
Durham & North. foundry	28/–
„ furnace ..	23/6
Other Districts, foundry	27/6
„ furnace	22/–

SWEDISH IRON.

Bars, hammered basis sizes Basis price	£22 to £23
Rolled Ordinary— Assortment ..	£17 0 0 to £17 10 0
Nail Rods— Square, round and flats ..	
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices are now free.
Water	50%	
Steam	45%	

TINPLATES.

I.C. Cokes,	20×14, box		19/1½
,,	28×20,	,,	38/3
,,	20×10,	,,	28/3
,,	18¾×14,	,,	19/6
I.X.		,,	44/-
I.X.X.		,,	51/-
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	16 16½
,,	28×20,	,,	33/6
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Terneplates,	28×20,	,,	35/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Sept.20	62	12	6	No change	
,, 21	62	12	6	,,	
,, 22	62	17	6	inc.	5/-
,, 25	63	5	0	,,	7/6
,, 26	63	2	6	dec.	2/6

Electrolytic Copper.

Sept.20	71	7	6	dec.	2/6
,, 21	71	2	6	,,	5/-
,, 22	71	2	6	No change	
,, 25	71	5	0	inc.	2/6
,, 26	71	5	0	No change	

Standard Tin (cash).

Sept.20	159	0	0	inc.	5/-
,, 21	165	10	0	inc.	30/-
,, 22	161	0	0	,,	10/-
,, 25	161	10	0	,,	10/-
,, 26	161	5	0	dec.	5/-

Tin (English ingots)

Sept.20	158	10	0	inc.	5/-
,, 21	160	0	0	inc.	30/-
,, 22	161	0	0	No change	
,, 25	161	10	0	inc.	10/-
,, 26	161	5	0	dec.	5/-

Zinc Sheets (English).

Sept.20	37	10	0	No change	
,, 21	37	10	0	,,	
,, 22	37	10	0	,,	
,, 25	37	10	0	,,	
,, 26	37	10	0	,,	

Spelter (ordinary).

Sept.20	31	12	6	No change	
,, 21	31	17	6	inc.	5/-
,, 22	32	5	0	,,	7/6
,, 25	32	7	6	,,	2/6
,, 26	32	5	0	dec.	2/6

Lead (English)

Sept.20	25	5	0	No change	
,, 21	25	5	0	,,	
,, 22	25	5	0	,,	
,, 25	25	5	0	,,	
,, 26	25	5	0	,,	

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WANTED, small Moulding Machine, hand or power, to handle boxes about 20 in. x 14 in. Jolt Ramming Machine, plain or with turnover table, to take boxes 3 ft. 6 in. square, 20 in. deep.—Box 262, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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40 pairs	16″ × 14″	4½″	4½″	Taper sides, C.I. ..	16/-
200 pairs	16″ × 14″	4½″	4½″	Straight sides, C.I.	12/6
150 pairs	18″ × 18″	5″	5″	Taper sides, C.I. ..	16/-
60 pairs	15½″ × 15½″	5″	5″	Taper sides, C.I. ..	14/-
200 pairs	18″ × 12″	4″	4″	Straight sides, C.I.	12/6
50 pairs	18″ × 12″	4″	4″	Pressed steel, by Macdonald.	15/-
60 pairs	16″ × 10″	4″	4″	Pressed steel, by Macdonald.	12/6
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lete—
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F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	35/-
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,,	28×20,	,,	33/6
,,	20×10,	,,	22/7½
,,	18¾×14,	,,	17/1½
Terneplates,	28×20,	,,	34/6

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Standard Copper (cash).

	£	s.	d.		
Sept.27	63	7	6	inc.	5/-
,, 28	63	12	6	,,	5/-
,, 29	63	17	6	,,	5/-
Oct. 2	63	12	6	dec.	5/-
,, 3	63	10	0	dec.	2/6

Electrolytic Copper.

Sept.27	71	5	0	No change	
,, 28	71	10	0	inc.	5/-
,, 29	71	10	0	No change	
Oct. 2	71	10	0	,,	
,, 3	71	10	0	,,	

Standard Tin (cash).

Sept.27	160	17	6	dec.	7/6
,, 28	161	12	6	inc.	15/-
,, 29	163	17	6	,,	45/-
Oct. 2	164	7	6	,,	10/-
,, 3	164	15	0	,,	7/6

Tin (English ingots)

Sept.27	161	0	0	dec.	5/-
Sept.28	161	15	0	inc.	15/-
,, 29	163	7	6	,,	42/6
Oct. 2	164	0	0	,,	12/6
,, 3	164	10	0	,,	10/-

Zinc Sheets (English).

Sept.27	37	10	0	No change	
,, 28	37	10	0	,,	
,, 29	37	10	0	,,	
Oct. 2	38	0	0	inc.	10/-
,, 3	38	0	0	No change	

Spelter (ordinary).

Sept.27	32	5	0	No change	
,, 28	32	5	0	,,	
,, 29	32	7	6	inc.	2/6
Oct. 2	32	10	0	,,	2/6
,, 3	32	15	0	,,	5/-

Lead (English).

Sept.27	25	19	0	inc.	5/-
,, 28	26	0	0	,,	10/-
,, 29	26	0	0	No change	
Oct. 2	26	0	0	,,	
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Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	0	0
Three months	63	12	6
Electrolytic	71	0	0
Tough	65	10	0
Best selected	65	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	17	6
Do. Nov.	70	17	6
Do. Dec.	70	17	6
Ingot bars	70	17	6
H.C. wire rods	76	0	0
Off. aver. cash, Sept.	63	3	4 5/7
Do. 3 mths., Sept.	63	12	5 2/7
Do. Settlement Sept.	63	2	11 5/7
Do. Electro, Sept.	71	3	2 4/7
Do. B.S., Sept.	67	0	0
Aver. spot price, copper, Sept.	63	2	7½
Do. Electro, Sept.	71	8	1

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8¼d.
Do. 4x3 Sheets .. 9¼d

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes 13½d
Rods, drawn .. .. 10¾d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

Standard cash	165	2	6
Three Months	163	5	0
English	164	12	6
Bars	166	12	6
Chinese	164	2	6
Straits	165	12	6
Australian	165	10	0
Eastern	166	15	0
Banca	165	5	0
Off. aver., cash, Sept.	160	2	8 1/7
Do. 3 mths., Sept.	160	0	7 6/7
Do. Sttlment Sept.	160	2	3 1/7
Aver. spot, Sept.	160	1	3¾

SPELTER.

Ordinary	33	0	0
Remelted	31	5	0
Hard	25	0	0
Electro 99.9	36	10	0
English	33	2	6
India	24	10	0
Prime Western	33	0	0
Zinc dust	48	0	0
Zinc ashes	10	15	0
Off. aver., Sept.	31	8	8 9/14
Aver., spot, Sept.	31	14	10½

LEAD.

Soft foreign ppt	25	7	6
English	26	10	0
Off. average, Sept.	23	16	3 5/14
Average spot, Sept.	24	2	9

ZINC SHEETS.

Zinc sheets, English	38	0	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	5	0
Boiler plates	36	0	0
Battery plates	36	10	0

ANTIMONY.

English regulus	27	0	0
Special brands	33	10	0
Chinese	25	10	0
Crude	17	0	0

QUICKSILVER.

Quicksilver 12 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 11 10 0
75% 20 0 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% 8/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1 lb.

Ferro-phosphorus, 20/23%, £27

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/11 lb.

Ferro-chrome—
4/6% car. £23 0
6/8% car. .. £22 12 6
8/10% car. .. £22

Ferro-chrome—
Max. 2% car. .. £55
Max. 1% car. .. £68
Max. 0.70% car. .. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £140

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 4/9 lb.

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb,
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	3	5	0	3	10	0
Bundled steel & shearings	2	16	6	3	7	6
Mixed iron & steel	2	15	0	3	2	6
Heavy cast iron	3	7	6	3	15	0
Good machinery for foundries	3	15	0	4	0	0

Cleveland—			
Heavy steel	3	5	0
Steel turnings	2	12	6
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	15	0
Cast-iron scrap	3	10	0

Lancashire—			
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	20	0	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—		
Foundry No. 1	97	6
Foundry No. 3	92	6
Forge No. 4	85	/-
Mottled	80	/-
Hematite No. 1	90	/9
Hematite M/Nos.	90	/-
Midlands—		
Staffs. common	—	
,, part-mine forge	—	
,, ,, foundry	—	
,, Cold blast	240	/-
,, basic	—	
Northants forge	70/- to 72/6	
,, foundry No. 3	77/6 ,, 80	/-
,, basic	80	/-
Derbyshire forge	75	/-
,, foundry No. 3	82	/6
,, basic	80	/-
Scotland—		
Foundry No. 1	105	/-
,, No. 3	100	/-
Hematite M/Nos.	107	/6
Sheffield (d/d district)—		
Derby forge	82	/6
,, foundry No. 3	86	/6
,, basic	—	
Lincs. forge	86	/6
,, foundry No. 3	86	/6
,, basic	86	/6
E.C. hematite	101	/-
W.C. hematite	102	/6

All d/d in the district.

Lancashire (d/d eq. Man.)		
Derby forge	—	
,, foundry No. 3	90	/-
Northants foundry No. 3	—	
Cleveland foundry No. 3	—	
Staffs. foundry No. 3	—	
Lincs. forge	—	
,, foundry No. 3	—	
Summerlee foundry	116	/6
Glengarnock foundry	118	/6
Gartsherrie foundry	118	/6
Monkland foundry	116	/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	15	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ⅜in.	9	5	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1½in.	8	5	0

	£	s.	d
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	7 0 0 to 7	2	6
Billets, hard	8	0	0
Sheet bar	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.26
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	27.00
Basic	35.96
Bessemer	35.77
Malleable	35.96
Grey forge	34 27
Ferro-manganese 80 % delivered	75.00
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2 47
Steel bars	2.10
Tank plates	2.25
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry .. 35/- to 37/6
,, furnace .. 26/- to 27/6
Durham & North. foundry 28/-
,, furnace .. 23/6
Other Districts, foundry 27/6
,, furnace 24/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £17 10 0 to £18 0 0

Nail Rods— Square, round and flats ..

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents here.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices
Water	50%	are
Steam	45%	now free.

TINPLATES.

I.C. Cokes,	20×14, box		18/9
,,	28×20,	,,	38/-
,,	20×10,	,,	27/9
,,	18¾×14,	,,	19 6
I.X.		,,	43 9
I.X.X.		,,	50 6
F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	35/-
I.C.W.	20×14,	,,	16 7½
,,	28×20,	,,	33/-
,,	20×10,	,,	22/9
,,	18¾×14,	,,	17/1½
Terneplates,	28×20,	,,	35/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Oct.	4	63	5	0	dec.	5/-
,,	5	63	0	0	,,	5/-
,,	6	62	10	0	,,	10/-
,,	9	63	2	6	inc.	12/6
,,	10	63	0	0	dec.	2/6

Electrolytic Copper.

Oct.	4	71	5	0	dec.	5/
,,	5	71	5	0	No change	
,,	6	71	5	0	,,	
,,	9	71	0	0	dec.	5/-
,,	10	71	0	0	No change	

Standard Tin (cash)

Oct.	4	163	5	0	dec.	30/-
,,	5	163	10	0	inc.	5/-
,,	6	163	10	0	No change	
,,	9	163	17	6	inc.	7/6
,,	10	165	2	6	,,	25/-

Tin (English ingots)

Oct.	4	163	0	0	dec.	30/-
,,	5	163	0	0	No change	
,,	6	163	0	0	,,	
,,	9	163	10	0	inc.	10/-
,,	10	164	12	6	,,	22/6

Zinc Sheets (English)

Oct.	4	38	0	0	No change	
,,	5	38	0	0	,,	
,,	6	38	0	0	,,	
,,	9	38	0	0	,,	
,,	10	38	0	0	,,	

Spelter (ordinary).

Oct.	4	33	0	0	inc.	5/-
,,	5	33	0	0	No change	
,,	6	33	0	0	,,	
,,	9	33	2	6	inc.	2/6
,,	10	33	0	0	dec.	2/6

Lead (English).

Oct.	4	26	5	0	No change	
,,	5	26	5	0	,,	
,,	6	26	5	0	,,	
,,	9	26	5	0	,,	
,,	10	26	10	0	inc.	5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works —
Hadley, Shropshire.

Telegrams :—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

London: 10, Bush Lane, Cannon St., E.C.4.

Telephone :—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, France-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK

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JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER desires Position, where experience and ability is required, as Foundry Foreman or Manager; 19 years' practical and technical training all branches iron and non-ferrous work; 9 years as Foreman and Manager. Experience on Motor, Engineering and Jobbing Work up to 20 tons. Expert on Cuploa, mix metals by analysis, knowledge of metallurgy; good organiser, tactful with labour. Guarantee consistent results. McLain and I.C.S. graduate.—Box 264, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER or Assistant, age 38, experienced Steam and Motor Cylinders, Pumps, etc., Quantity Production, desires Engagement. Patterns, Moulding Equipment, Mixing by Analysis, Cupola Practice, extensive Experience of Oil Sand Cores, Core Jigging, modern Core- and Mould-drying Stoves. Knowledge costing and estimating. A.M.I.Brit.F.—Replies, "M.," Hill View, Pollards Hill West, Norbury, London, S.W.16.

FOUNDRY FOREMAN (31) desires progressive and responsible situation; technical and practical experience in up-to-date methods of production; Green and Dry Sand, Plate and Machine, Pattern Plates, Core Making, personally operated Cupola, mix to analysis; good organiser.—Box 272, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

HIGH-CLASS and Practical Foundryman wants Job as Foundry Manager, Foreman, or Assistant Foreman; age 30. Past four years foreman, then manager of large motor firm's foundries, doing big production in iron, aluminium and brasses. Undoubted ability and sound credentials.—Apply Box 276, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, FIRST-CLASS MACHINE CORE MAKER. State age, wages, experience of Machines, to Box 272, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENCIES.

SOLE AGENTS required in all industrial districts in Great Britain, and also for Foreign and Colonial Countries, for an entirely new Foundry Product, which is now being used by some of the leading foundries with every satisfaction; time saving and efficiency in its use; splendid opportunity for live firms. State district.—Write Box 260, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ACTIVE AGENT, established in Belgium, well up in Metallurgical Trade, in constant touch with Rolling Mills of South Belgium and Luxembourg, wishes to act as Buying Agent on commission for large English Builders or Exporters. Best references. —Write to A. K., Eclair-Publicite, Charleroi, Belgium.

MACHINERY.

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—Stansell's Acetylene Company, Limited, Exeter.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

WANTED, small Moulding Machine, hand or power, to handle boxes about 20 in. x 14 in. Jolt Ramming Machine, plain or with turnover table, to take boxes 3 ft. 6 in. square, 20 in. deep.—Box 262, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY —*Contd.*

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOR SALE.

Two Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20 in. cylinders, 26 in. stroke, by Robey and Company, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cylinders, 26 in. stroke, by Marshall, Sons and Company, Limited. Vertical Compound Open Type Engine, 15 in. and 22 in. cylinders, 18 in. stroke, by Browett, Lindley and Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cylinders, 12 in. stroke, by Tangyes, Limited. Nearly New Surface Condensing Plant, by F. Pearn and Company, 10 in. and 16 in. steam cylinders, 12 in. stroke, surface area of tubes about 1,200 ft. Worthington Steam-Driven Jet Condensing Plant, 7½ in. and 12 in. steam cylinders, pump bucket 16 in., 12 in. stroke, 7,000 lbs. condensed steam per hour. 8 ft. Vertical Boring and Turning Mill, by J. Hetherington and Company, to take 5 ft. underneath tool boxes, two swivel tool boxes. Planing Machine, to plane 14 ft. by 5 ft. by 4 ft., two tool boxes on cross slide, by J. Buckton and Company, Limited. Multiple Punching Machine, by Rushworth and Company, capacity 33 holes—17/32 in. diameter through plates 3/16 in. thick, 3 in. pitch. 12 in. stroke Shaping Machine, quick return motion, two tables, 21 in. by 13 in. by 13 in., by Jas. Archdale and Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

OIL-ENGINE DRIVEN COMPRESSOR, by Blackstone, 300 lbs. pressure, 120 cubic ft. per minute, 45 h.p.; as new. 26¼ kw. New Steam Generating Set, by Browett Lindley-Laurence Scott, 110 volts. 20-h.p. 220-volt Siemens Motor and Starting Panel; as new. Two nearly new Sand Mills, 32-in. pan.—Harry H. Gardam & Company, Limited, Staines.

WANTED.—One Foundry Ladle only, 10 cwts. capacity, and complete with slings.—Reply, Box 252, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATENTS.

ADVICE and Handbook Free.—King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

MISCELLANEOUS

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

PATTERNS of Every Description, Large or Small. Let us quote you for sound, accurate, well-finished Pattern, or a cheap rough job. We can give you quick delivery at keen prices. Fully-electrically-equipped works; over 30 years' practical experience.—Walter Totty, Greenfoot Pattern Works, Old Town, Barnsley.

CUPOLA

30 in. ALLDAY8 CUPOLA, with hood and lining bricks, drop bottom, very good condition, in stock here, **£55 on rail**; blower to suit, **£12** extra.

TILTING FURNACES

MORGAN TILTING FURNACES, S. type, 600 lb. capacity, coke-fired, ex-Government (six in stock) .. each **£60**

Miscellaneous Plant

Belt-driven **SAND SIFTER** **£9**
2 Coke-fired **CORESTOVES,** Radial Shelves, by C. D. Phillips .. .. each **£18**
1 **6-ft SANDMILL,** as new, under-driven, revolving pan .. **£65**
1 **4-ft SANDMILL** **£28**
SAND-MIXER, Vertical Cage Type, by C. E. V. Hall .. **£22**
60 **STEEL COREPLATES,** 22 in. square .. .. each **6s.**
2 **PNEUMATIC HOISTS,** by TABOR, as new, 6 ft. travel .. **£9**
CLIMAX COREWIRE STRAIGHTENER, 1/16th in. to ¼ in. capacity **£16**
BALL MILL for grinding coal **£22**
GIT CUTTER for brass castings, good condition **£32**
BANDSAW for brass castings, by Noble & Lund .. **£45**
ELECTRIC FURNACE, by HEROULT, 3½ ton, new.
2-ton "8TOCK" CONVERTER PLANT, new.
800 pairs of MOULDING BOXES (send for list)
WOOD PATTERN 8HOP OUTFIT, send for list, offered very cheap

ALEX. HAMMOND, *Foundry Machinery Merchant,* **'BOXTED' SLOUGH**

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 10 0 to 18 0 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box		19/3
,,	28×20,	,,	38/6
,,	20×10,	,,	28/3
,,	18¾×14,	,,	18/9
I.X.		,,	43 9
I.X.X.		,,	50,6
F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	35/-
I.C.W.	20×14,	,,	17/-
,,	28×20,	,,	33/6
,,	20×10,	,,	22/9
,,	18¾×14,	,,	17/3
Terneplates,	28×20,	,,	34/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Oct. 11	62	12	6	dec.	7/6
,, 12	62	2	6	,,	10/
,, 13	62	12	6	inc.	10/-
,, 16	62	12	6	No change	
,, 17	62	10	0	dec.	2/6

Electrolytic Copper.

Oct. 11	71	0	0	No change	
,, 12	70	10	0	dec.	10/
,, 13	71	0	0	inc.	10/-
,, 16	71	0	0	No change	
,, 17	71	0	0	,,	

Standard Tin (cash).

Oct. 11	165	17	6	inc.	15/-
,, 12	166	5	0	,,	7/6
,, 13	167	12	6	,,	27/6
,, 16	168	17	6	,,	25/-
,, 17	169	7	6	,,	10/-

Tin (English ingots)

Oct. 11	165	10	0	inc.	17/6
,, 12	165	15	0	inc.	5/-
,, 13	167	2	6	,,	27/6
,, 16	168	7	6	,,	25/-
,, 17	169	0	0	,,	12/6

Zinc Sheets (English).

Oct. 11	39	0	0	inc.	20/-
,, 12	39	0	0	No change	
,, 13	39	0	0	,,	
,, 16	39	0	0	,,	
,, 17	39	10	0	inc.	10/-

Spelter (ordinary).

Oct. 11	32	15	0	dec.	5/-
,, 12	32	17	6	inc.	2/6
,, 13	33	2	6	,,	5/-
,, 16	33	17	6	,,	15/-
,, 17	34	5	0	,,	7/6

Lead (English).

Oct. 11	26	10	0	No change	
,, 12	26	10	0	,,	
,, 13	26	10	0	,,	
,, 16	26	15	0	inc.	5/
,, 17	26	15	0	No change	

There's something for You among these

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

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LUMPS

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31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

FOUNDRY MANAGER or Assistant, age 38, experienced Steam and Motor Cylinders, Pumps, etc., Quantity Production, desires Engagement. Patterns, Moulding Equipment, Mixing by Analysis, Cupola Practice, extensive Experience of Oil Sand Cores, Core Jigging, modern Core- and Mould-drying Stoves. Knowledge costing and estimating. A.M.I.Brit.F.—Replies, "M.," Hill View, Pollards Hill West, Norbury, London, S.W.16.

FOUNDRY FOREMAN (31) desires progressive and responsible situation; technical and practical experience in up-to-date methods of production; Green and Dry Sand, Plate and Machine, Pattern Plates, Core Making, personally operated Cupola, mix to analysis; good organiser.—Box 272, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

HIGH-CLASS and Practical Foundryman wants Job as Foundry Manager, Foreman, or Assistant Foreman; age 30. Past four years foreman, then manager of large motor firm's foundries, doing big production in iron, aluminium and brasses. Undoubted ability and sound credentials.—Apply Box 276, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, FIRST-CLASS MACHINE CORE MAKER. State age, wages, experience of Machines, to Box 274, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—One Foundry Foreman for heavy marine work and one for light castings and cylinders in Great Britain; McLain Graduates preferred.—State age, experience and salary first letter to McLain's System (Inc.), 710, Goldsmith Building, Milwaukee, Wis.

AGENCIES.

ACTIVE AGENT, established in Belgium, well up in Metallurgical Trade, in constant touch with Rolling Mills of South Belgium and Luxembourg, wishes to act as Buying Agent on commission for large English Builders or Exporters. Best references. —Write to A. K., Eclair-Publicite, Charleroi, Belgium.

AUCTION SALE.

THE CITY FOUNDRY,
No. 388a, STAPLETON ROAD,
BRISTOL.

WILLIAM R. NURSE & SONS are instructed to SELL by AUCTION (in consequence of the dissolution of partnership), on the Premises, on

WEDNESDAY, OCTOBER 25th, 1922,

MACHINERY, BUILDINGS, AND EFFECTS,

Comprising: Drilling Machine (large type), Rumbler, Emery Wheel, Blower, Blower Fan (Lloyd's Patent), 4½-h.p. Gas Engine (Crossley), smaller Gas Engine, Gas Engine and Dynamo, TRAVELLING CRANE and GANTRY, several Moulding Box Parts, Shafting and Pulleys, DAIMLER 30-cwt. MOTOR-LORRY, in capital condition, Platform Weighing Machine (to weigh 1 ton), also large BRICK BUILDING and small ditto.

The whole will first be offered in One Lot, and the Purchaser would have the option of Renting the Premises. If not sold in One Lot will be sold separately, the Buildings to be Removed by the Purchasers.

SALE at TWO o'clock.

For further Particulars apply to the Auctioneers, 41, Nicholas Street; to EVANS & TAYLOR, Solicitors, 35, Nicholas Street, Bristol; or to WANSBROUGHS, ROBINSON, TAYLER & TAYLOR, Solicitors, Bristol, Devizes, and Melksham.

PATENTS.

ADVICE and Handbook Free.—King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

MACHINERY.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOR SALE.

Two Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20 in. cylinders, 26 in. stroke, by Robey and Company, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cylinders, 26 in. stroke, by Marshall, Sons and Company, Limited. Vertical Compound Open Type Engine, 15 in. and 22 in. cylinders, 18 in. stroke, by Browett, Lindley and Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cylinders, 12 in. stroke, by Tangyes, Limited. Nearly New Surface Condensing Plant, by F. Pearn and Company, 10 in. and 16 in. steam cylinders, 12 in. stroke, surface area of tubes about 1,200 ft. Worthington Steam-Driven Jet Condensing Plant, 7½ in. and 12 in. steam cylinders, pump bucket 16 in., 12 in. stroke, 7,000 lbs. condensed steam per hour. 8 ft. Vertical Boring and Turning Mill, by J. Hetherington and Company, to take 5 ft. underneath tool boxes, two swivel tool boxes. Planing Machine, to plane 14 ft. by 5 ft. by 4 ft., two tool boxes on cross slide, by J. Buckton and Company, Limited. Multiple Punching Machine, by Rushworth and Company, capacity 33 holes—17/32 in. diameter through plates 3/16 in. thick, 3 in. pitch. 12 in. stroke Shaping Machine, quick return motion, two tables, 21 in. by 13 in. by 13 in., by Jas. Archdale and Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

OIL-ENGINE DRIVEN COMPRESSOR, by Blackstone, 300 lbs. pressure, 120 cubic ft. per minute, 45 h.p.; as new. 26½ kw. New Steam Generating Set, by Browett Lindley-Laurence Scott, 110 volts. 20-h.p. 220-volt Siemens Motor and Starting Panel; as new. Two nearly new Sand Mills, 32-in. pan.—Harry H. Gardam & Company, Limited, Staines.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. Hall, 26, Paradise Square, Sheffield.

MISCELLANEOUS

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

PATTERNS of Every Description, Large or Small. Let us quote you for sound, accurate, well-finished Pattern, or a cheap rough job. We can give you quick delivery at keen prices. Fully-electrically-equipped works; over 30 years' practical experience.—Walter Totty, Greenfoot Pattern Works, Old Town, Barnsley.

CUPOLAS

No. 1 GREEN CUPOLETTE with extension piece, 480-volt D.C. electric fan, starter, etc. £35
30" ALLDAYS' CUPOLA, drop bottom, excellent condition, F.O.R. £55
Blower £12 extra.

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PNEUMATIC.

1 TABOR POWER SQUEEZER for boxes 26" × 26" 12" power draft £100
4 TABOR STANDARD TYPE, 16" × 14" POWER DRAFT SQUEEZERS .. .. .. each £80
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1 TABOR TURNOVER POWER SQUEEZER for 18" × 12" boxes £70
2 EVANS' DUPLEX MACHINES for 18" .. 18" boxes, latest type .. .. each £90
3 JACKMAN 3" JOLTS, new condition .. .. each £28
16" TABOR PLAIN JOLT, table 6 ft. square, new .. £400

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2 "COVENTRY" HEAD RAM MACHINES by Britannia Foundry Co., new .. .. each £25
2 EVANS' FLYPRESS TYPE SQUEEZERS for 13" × 13" boxes .. .. each £12
4 TURNOVER MACHINES by Phillips for 16" × 14" boxes .. .. each £14
1 PRIDMORE ROCKOVER DROP MACHINE for 20" × 14" boxes £40
1 DARLING & SELLARS MACHINE, Turnover type, for 36" × 24" boxes £30
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SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 10 0 to 18 0 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
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Single welded .. £10 to £11

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Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices are now free.
Water	50%	
Steam	45%	

TINPLATES.

I.C. Cokes,	20×14, box	19/3
„	28×20, „	38/6
„	20×10, „	28/3
„	18¾×14, „	19/3
I.X.	„	45/-
I.X.X.	„	51/-
F.C.B.Y.	21×13⅝ „	36/6
C.V.B.G.	16¾×15, „	35/-
I.C.W.	20×14, „	16/10½
„	28×20, „	33/3
„	20×10, „	23/3
„	18¾×14, „	17/1½
Terneplates,	28×20, „	35/9

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Oct. 18	62	5	0	dec.	5/-
„ 19	62	0	0	„	5/-
„ 20	61	17	6	„	2/6
„ 23	62	10	0	inc.	12/6
„ 24	63	0	0	„	10/-

Electrolytic Copper.

Oct. 18	70	10	0	dec.	10/-
„ 19	70	0	0	„	10/-
„ 20	70	0	0	No change	
„ 23	70	5	0	inc.	5/-
„ 24	70	5	0	No change	

Standard Tin (cash).

Oct. 18	171	0	0	inc.	32/6
„ 19	172	5	0	„	25/-
„ 20	171	15	0	dec.	10/-
„ 23	173	5	0	inc.	30/-
„ 24	174	7	6	„	22/6

Tin (English ingots)

Oct. 18	170	10	0	inc.	30/-
Oct. 19	171	10	0	inc.	20/6
„ 20	171	5	0	dec.	5/-
„ 23	172	15	0	inc.	30/-
„ 24	174	5	0	„	30/-

Zinc Sheets (English).

Oct. 18	39	10	0	No change
„ 19	39	10	0	„
„ 20	39	10	0	„
„ 23	40	0	0	inc. 10/-
„ 24	40	0	0	No change

Spelter (ordinary).

Oct. 18	34	10	0	inc.	5/-
„ 19	35	7	6	„	17/6
„ 20	36	0	0	„	12/6
„ 23	35	17	6	dec.	2/6
„ 24	36	2	6	inc.	5/

Lead (English).

Oct. 18	26	10	0	dec.	5/-
„ 19	26	5	0	„	5/-
„ 20	26	5	0	No change	
„ 23	26	10	0	inc.	5/-
„ 24	27	10	0	„	20/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

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BARS, HOOPS, SECTIONS & WIRE
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Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

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BEST H. C. COPPER & BRONZE WIRE a speciality.

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SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. Makemson, 21, Beresford Road, Stretford, Manchester.

WANTED, FIRST-CLASS MACHINE CORE MAKER. State age, wages, experience of Machines, to Box 274, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—One Foundry Foreman for heavy marine work and one for light castings and cylinders in Great Britain; McLain Graduates preferred.—State age, experience and salary first letter to McLain's System (Inc.), 710, Goldsmith Building, Milwaukee, Wis.

PROPERTIES FOR SALE.

FOR SALE by Private Treaty, MODERN IRON-FOUNDRY, FREEHOLD LAND and BUILDINGS, covering an area of 1,865 square yards, complete with all Plant, including two Cupolas, 4 ft. 3 in. and 3 ft. 9 in. dia., together with Fans, 10-ton Electric Overhead Travelling Crane, Loam Mill, Sand Mixer, Moulding Boxes, etc., within two minutes of Wakefield (Kirkgate) Goods Station. Part purchase price can remain.—For permission to view, apply Joseph Rhodes & Sons, Limited, Grove Iron Works, Wakefield.

WAGON WORKS FOR SALE as a Going Concern. The property is situate on the Great Eastern Railway within 100 miles of London. The Buildings are well adapted for the work, and are fully equipped with up-to-date Plant. The Business has been in existence for many years and showing profits. The price of £11,000 represents the value of the Land, Buildings and Plant, and nothing is asked for Goodwill. The Stock, Stores and work-in-progress could be taken over at a valuation, if desired.—Full particulars may be obtained of Fuller, Horsey, Sons & Cassell, 11, Billiter Square, London, E.C.3.

FOR SALE as a going concern, the business of Messrs. W. J. & C. T. Burgess, Engineers and Iron Founders, Victoria Works, Brentwood, Essex.

FREEHOLD LAND AND BUILDINGS: These comprise a site area of approximately 4 acres, and the Buildings include large and well-arranged Engineering and Foundry Premises, containing Machine Shops, Smiths' Shop, Foundries, Stores, Sheds, Offices, etc., together with a well-built Residence and two Cottages.

THE PREMISES, situate close to 'bus routes, are within easy access of the G.E. Rly., possessing an extensive frontage to Ongar Road of about 800 ft.

PLANT AND MACHINERY: The main Machine Shop is well equipped with about 50 Machine Tools, including Lathes, Planes, Drillers, Slotters, Grinders, etc.

FOUNDRY EQUIPMENT: This includes 2 Cupolas, 4 Pot Furnaces, and upwards of 50 tons of Foundry Boxes, etc.

SPECIALITIES AND PATENTS manufactured by this Firm include Engineers' Quick Grip Vices, Bucket Pumping Machinery, Saw Cotton Gin, Field Mower parts, Portable Hand Baling Press, and Motor Lawn Mowers, of which they possess drawings, patterns, patents, jigs, and unassembled parts. The business was established in 1849, and has been in the same family ever since.

There is also a quantity of STOCK and STORES, and well-fitted offices. Plans may be inspected and further information with order to view obtained from the Trustee, H. T. Bloor, Esq., Messrs. W. F. Smart, Son & Bloor, 255, Finsbury Pavement House, E.C.2, or Messrs. Henry Butcher & Company, Auctioneers, Valuers and Surveyors, 63 and 64, Chancery Lane, W.C.2.

To THE EDITOR of the Foundry Trade Journal.

Please send me details of the visit to the International Foundry Trade Congress and Exhibition to be held in Paris next September.

Name.....

Address.....

.....

MACHINERY.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOR SALE.

6-Wheel Coupled Saddle Tank Locomotive (Manning Wardles), with inside cyls., 12 in. dia. x 18 in. stroke, 4 ft. 8½ in. gauge, 140 lbs. W.P., sale or hire 5-Ton "Grafton" Loco. Steam Crane, with 35 ft. steel latticed jib, 4 ft. 8½ in. gauge, boiler 7 ft. 6 in. x 3 ft. 6 in., for about 80 lbs. W.P. 3-Ton "Grafton" ditto, with 27 ft. 6 in. steel latticed derricking jib, 4 ft. 8½ in. gauge, boiler 7 ft. 6 in. x 3 ft., for 70 lbs. W.P. Six 2-Ton Steam Transporter and Jib Cranes (Ransome & Rapier), 21 ft. max. radius, 10 ft. gauge, boiler 7 ft. 6 in. x 3 ft. 6 in., for 100 lbs. W.P. Practically new 4-Ton Hand Derrick Crane, with 40 ft. timber jib. Mortar Mills, 9 ft., 7 ft., 6 ft., and 4 ft. sizes. 4-Wheel Coupled Saddle Tank Locomotive (Hawthorn Leslies), with outside cyls., 14 in. dia. x 20 in. stroke, 4 ft. 8½ in. gauge, 140 lbs. W.P.; sale or hire.

Catalogue of Stock Machinery, 6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

FOR SALE.—1—150-lb. Morgan's Brass Tilting Furnace, type S., coke-fired, complete, nearly new.—Box No. 280, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

OIL-ENGINE DRIVEN COMPRESSOR, by Blackstone, 300 lbs. pressure, 120 cubic ft. per minute, 45 h.p.; as new. 26¼ kw. New Steam Generating Set, by Browett Lindley-Laurence Scott, 110 volts. 20-h.p. 220-volt Siemens Motor and Starting Panel; as new. Two nearly new Sand Mills, 32-in. pan.—Harry H. Gardam & Company, Limited, Staines.

WANTED.—MOULDING MACHINE, preferably "Tabor" type, if possible including Compressor; must be in running condition and cheap; London area preferred.—Full details to Box No. 282, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—Good second-hand 4- or 5-ton geared Foundry Ladle.—Full particulars, including taper, thickness of plates, price, etc., to The United Steel Companies, Limited, Butlin Branch, Wellingborough.

PATENTS.

ADVICE and Handbook Free.—King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. Adamson, Ushaw Moor, County Durham.

PATTERNS of Every Description, Large or Small. Let us quote you for sound, accurate, well-finished Pattern, or a cheap rough job. We can give you quick delivery at keen prices. Fully-electrically-equipped works; over 30 years' practical experience.—Walter Totty, Greenfoot Pattern Works, Old Town, Barnsley.

WANTED.

STEEL FOUNDRY PLANT.

TROPENAS CONVERTER, 1 to 1½ tons capacity, also a 2/3 ton Converter.
BLOWERS to suit—belt or motor driven.
CUPOLA about 4 feet diameter.
SAND BLAST room about 12 feet square or larger, with table preferred.
TURNOVER JOLT ram moulding machine of large size; also several smaller *plain jolters*, by Britannia or Jackman.
LADLES—Two 5 ton lip pouring ladles.
Two 3 " " " "
One 1 " " " "
Two 2 " " " "
Several bottom pouring ladles
Offers of other useful plant also invited.

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"Coal Economy is in the Air"

On the one hand

Natural Draught with costly brick chimney emitting black smoke that spells waste and the draught at the mercy of the atmospheric conditions.

Send for Catalogue No. 1009.

On the other hand

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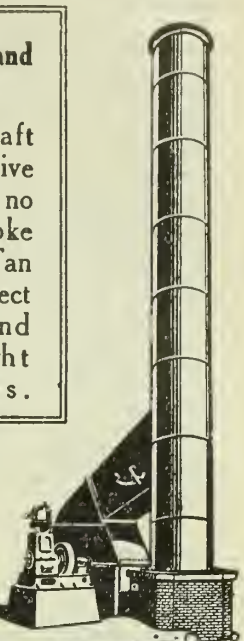
Induced Draft with inexpensive steel stack and no wasteful smoke because the Fan ensures perfect combustion and correct draught at all times.



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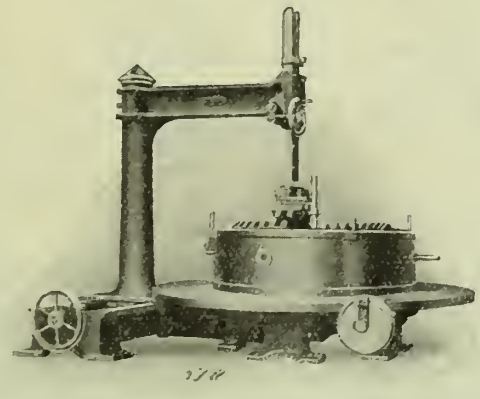

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BOLTON.

WHEEL MOULDING MACHINES

For SPUR, BEVIL, STRAIGHT & DOUBLE HELICAL WHEELS.

MACHINE IS PROVIDED WITH SCOTT DIVIDING APPARATUS AND REQUIRES NO CHANGE WHEELS.

We also make

A FLOOR or PILLAR WHEEL MOULDING MACHINE

With your enquiry state the maximum diameter you wish to make.

LARGE NUMBER OF MACHINES AT WORK.
CAN BE SEEN IN OPERATION BY APPOINTMENT.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	0	0
Three months	63	12	6
Electrolytic	70	5	0
Tough	65	0	0
Best selected	65	0	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	0	0
Do. Nov.	70	0	0
Do. Dec.	70	0	0
Ingot bars	70	0	0
H.C. wire rods	74	15	0
Off. aver. cash, Sept. 63	3	4 5/7	
Do. 3 mths., Sept. 63	12	5 2/7	
Do. Settlement Sept. 63	2	11 5/7	
Do. Electro, Sept. 71	3	2 4/7	
Do. B.S., Sept.	67	0	0
Aver. spot price, copper, Sept.	63	2	7½
Do. Electro, Sept. 71	8	1	
Solid drawn tubes		13½d.	
Brazed tubes		13½d.	
Wire		10½d.	
Yellow metal rods		6½d.	
Do. 4x4 Squares		8½d.	
Do. 4x3 Sheets		9¼d.	

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9½d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	184	0	0
Three Months	184	10	0
English	184	0	0
Bars	186	0	0
Chinese	183	0	0
Straits	185	7	6
Australian	185	0	0
Eastern	188	0	0
Banca	184	2	6
Off. aver, cash, Sept.	160	2	8 1/7
Do. 3 mths., Sept.	160	0	7 2/7
Do. Sttlment Sept.	160	2	3 1/7
Aver. spot, Sept.	160	1	3¾

SPELTER.

	£	s.	d.
Ordinary	37	10	0
Remelted	34	10	0
Hard	28	10	0
Electro 99.9	39	0	0
English	37	0	0
India	29	10	0
Prime Western	37	0	0
Zinc dust	48	0	0
Zinc ashes	11	0	0
Off. aver., Sept.	31	8	8 9/14
Aver., spot, Sept.	31	14	10½

LEAD.

	£	s.	d.
Soft foreign ppt	27	0	0
English	28	0	0
Off. average, Sept.	23	16	3 5/14
Average spot, Sept.	24	2	9

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	40	0	0
Do. V.M. ex. whf	40	0	0
Dutch	40	10	0
Rods	46	0	0
Boiler plates	38	10	0
Battery plates	39	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	10	0
Crude	18	10	0

QUICKSILVER

	£	s.	d.
Quicksilver	12	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
45/50%	11	2	6
75%	19	10	0

Ferro-vanadium— 35/40%	17/- lb. va.
Ferro-molybdenum— 70/75%	8/9 lb. mo.
Ferro-titanium— 23/25%, carbonless	1/2 lb.
Ferro-phosphorus, 20/23%	£24
Ferro-tungsten— 80/85%, carbon free	1/5 lb.
Tungsten metal powder— 98/99%	1/11 lb.
Ferro-chrome— 4/6% car.	£23 5
6/8% car.	£22 15
8/10% car.	£22 10
Ferro-chrome— Max. 2% car.	£55
Max. 1% car.	£68
Max. 0.70% car.	£75
67/70%, carbonless	1/6½ lb.
Nickel—99%, cubes or pellets	£137 10
Cobalt metal—98/99%	12/- lb.
Aluminium—98/99%	£100
Metallic Chromium— 96/98%	4 9 lb.
Ferro-manganese (net)— 76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14 10
Metallic manganese— 94/96%, carbonless	2/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d lb.
Flats under 1 in. by ⅛ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections	6d. lb.
If in coils	3d. lb.
Packing	£3 ton.
Bars cut to length	10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—£ s. d.			
Heavy Steel 3 10 0	3	15	0
Bundled steel & shearings 2 17 6	3	10	0
Mixed iron & steel 2 18 0	3	5	0
Heavy cast iron 3 7 6	3	12	6
Good machinery for foundries	4	0	0
Cleveland—			
Heavy steel	3	8	0
Steel turnings	2	14	0
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	16	3
Cast-iron scrap	3	15	0
Lancashire—			
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6
London—			
Copper (clean)	56	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	21	10	0
Tea lead	19	0	0
Zinc	23	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	92/6
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	93/3
Hematite M/Nos.	92/6
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	105/-
„ No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	87/6
„ basic	86/6
E.C. hematite	102/-
W.C. hematite	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.) £10 10 to 11	10	0	
Angles £10 15 to 11	15	0	
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	15	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip £10 10 to 10	15	0	
Bolts and nuts, ¾ in. × 4 in.	17	10	0
Steel—			
Ship plates £9 to 9	10	0	
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles £8 12 6 to 9	0	0	
Tee £9 12 6 to 10	0	0	
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ⅝in.	8	15	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1¼in.	8	5	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops £11 0 0 to 11	10	0	
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	12	15	0
Billets, soft 7 0 0 to 7	2	6	
Billets, hard	8	0	0
Sheet bar 6 17 6 to 7	7	6	

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3¾
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6¾ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	33.14
No. 2 foundry Valley	32.50
No. 2 foundry, Birm.	27.50
Basic	31.96
Bessemer	35.27
Malleable	34.96
Grey forge	32.77
Ferro-manganese 80 % delivered	75.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.47
Steel bars	2.00
Tank plates	2.15
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.90
Sheets, black, No. 28	3.50
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 37/6
„ furnace	26/- to 27/6
Durham & North. foundry	30/-
„ furnace	27/-
Other Districts, foundry	30/-
„ furnace	26/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 10 0 to 18 0 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/3
,,	28×20, ,,	38/6
,,	20×10, ,,	28/3
,,	18¾×14, ,,	19/9
I.X.	,,	45/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝, ,,	36/6
C.V.B.G.	16¾×15, ,,	34/9
I.C.W.	20×14, ,,	17/6
,,	28×20, ,,	34/6
,,	20×10, ,,	24/-
,,	18¾×14, ,,	18/-
Terneplates,	28×20, ,,	36/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Oct. 25	62	17	6	dec.	2/6
,, 26	62	15	0	,,	2/6
,, 27	62	12	6	,,	2/6
,, 30	63	2	6	inc.	10/-
,, 31	63	0	0	dec.	,, 2/6

Electrolytic Copper.

Oct. 25	70	5	0	No change
,, 26	70	5	0	,,
,, 27	70	5	0	,,
,, 30	70	5	0	,,
,, 31	70	5	0	,,

Standard Tin (cash).

Oct. 25	176	15	0	inc.	47/6
,, 26	177	7	6	,,	12/6
,, 27	180	10	0	,,	62/6
,, 30	184	10	0	,,	80/-
,, 31	184	0	0	dec.	10/-

Tin (English ingots)

Oct. 25	176	5	0	inc.	40/-
,, 26	177	0	0	inc.	15/-
,, 27	180	0	0	,,	60/-
,, 30	184	5	0	,,	85/-
,, 31	184	0	0	dec.	5/-

Zinc Sheets (English).

Oct. 25	40	0	0	No change
,, 26	40	0	0	,,
,, 27	40	0	0	,,
,, 30	40	0	0	,,
,, 31	40	0	0	,,

Spelter (ordinary).

Oct. 25	36	10	0	inc.	7/6
,, 26	37	10	0	,,	20/-
,, 27	37	0	0	dec.	10/-
,, 30	37	0	0	No change	
,, 31	37	10	0	inc.	10/-

Lead (English).

Oct. 25	28	5	0	inc.	15/-
,, 26	28	5	0	No change	
,, 27	27	15	0	dec.	10/-
,, 30	27	15	0	No change	
,, 31	28	0	0	inc.	5/-

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

PRACTICAL CORE MAKER desires situation; wide and varied experience iron, steel and brass, motor, locomotive, textile and general engineering; 25 years at the trade, 10 years as Foreman, specialising in Oil, Sand, Plaster and Metal Core Box making, Sand Reclaiming, Machine and Hand Cores; progressive, up-to-date, possessing tact; used to control; skilled or semi-skilled labour; used to piece work; highest references.—Box No. 284, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—One Foundry Foreman for heavy marine work and one for light castings and cylinders in Great Britain; McLain Graduates preferred.—State age, experience and salary first letter to McLain's System (Inc.), 710, Goldsmith Building, Milwaukee, Wis

PROPERTIES FOR SALE.

FOR SALE by Private Treaty, MODERN IRON-FOUNDRY, FREEHOLD LAND and BUILDINGS, covering an area of 1,865 square yards, complete with all Plant, including two Cupolas, 4 ft. 3 in. and 3 ft. 9 in. dia., together with Fans, 10-ton Electric Overhead Travelling Crane, Loam Mill, Sand Mixer, Moulding Boxes, etc., within two minutes of Wakefield (Kirkgate) Goods Station. Part purchase price can remain.—For permission to view, apply JOSEPH RHODES & SONS, LIMITED, Grove Iron Works, Wakefield.

FOR SALE as a going concern, the business of Messrs. W. J. & C. T. Burgess, Engineers and Iron Founders, Victoria Works, Brentwood, Essex.

FREEHOLD LAND AND BUILDINGS: These comprise a site area of approximately 4 acres, and the Buildings include large and well-arranged Engineering and Foundry Premises, containing Machine Shops, Smiths' Shop, Foundries, Stores, Sheds, Offices, etc., together with a well-built Residence and two Cottages.

THE PREMISES, situate close to 'bus routes, are within easy access of the G.E. Rly., possessing an extensive frontage to Ongar Road of about 800 ft.

PLANT AND MACHINERY: The main Machine Shop is well equipped with about 50 Machine Tools, including Lathes, Planes, Drillers, Slotters, Grinders, etc.

FOUNDRY EQUIPMENT: This includes 2 Cupolas, 4 Pot Furnaces, and upwards of 50 tons of Foundry Boxes, etc.

SPECIALITIES AND PATENTS manufactured by this Firm include Engineers' Quick Grip Vices, Bucket Pumping Machinery, Saw Cotton Gin, Field Mower parts, Portable Hand Baling Press, and Motor Lawn Mowers, of which they possess drawings, patterns, patents, jigs, and unassembled parts. The business was established in 1849, and has been in the same family ever since.

There is also a quantity of STOCK and STORES, and well-fitted offices. Plans may be inspected and further information with order to view obtained from the Trustee, H. T. BLOOR, ESQ., MESSRS. W. F. SMART, SON & BLOOR, 255, Finsbury Pavement House, E.C.2, or MESSRS. HENRY BUTCHER & COMPANY, Auctioneers, Valuers and Surveyors, 63 and 64, Chancery Lane, W.C.2.

PATENTS.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE Proprietor of the Patent No. 2,324 of 1912, for Improvements in Methods of Producing Wrought Shapes of Manganese Steel, is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed, in the first instance, to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE Proprietor of the Patent No. 1,479 of 1912, for Improvements Relating to the Manufacture of Manganese Steel, is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed, in the first instance, to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

PATENTS.—*Cont.*

OWNER of protected secret alloy, light, strong and durable metal, thoroughly tested for bushes and highly recommended, would sell for lump sum or for sum and royalty.—Address, "ALLOY," Wm. Porteous & Company, Advertising Agents, Glasgow.

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FOR SALE.

Cross Compound Horizontal Corliss Engine, 15 in. and 24 in. cyls., 36 in. stroke, by D. Adamson & Company. Two Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20 in. cyls., 26 in. stroke, by Robey & Company, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cyls., 26 in. stroke, by Marshall Sons & Company, with Proells valve gear and jet condensor. Cross Compound Horizontal Surface Condensing Engine, 11½ in. and 17½ in. cyls., 18 in. stroke, by Marshall Sons & Company, Limited. Vertical Compound Open Type Engine, 15 in. and 21 in. cyls., 16 in. stroke, by Robey & Company, Limited. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Ingersoll Sergeant Direct Line Steam-driven Air Compressor, 14¼ in. air cyl., 14 in. steam, 14 in. stroke, capacity 384 cub. ft. free air per minute. Three Generating Sets, Vertical Compound Engine, by Bellis & Morcom, direct coupled to Generator, 105 volts, 500 amps., 400 revs. Three 75 B.H.P. Shunt Wound Motors, by Vickers, 440 volts, 600 revs., with pulley. Two 60 B.H.P. Shunt Wound Motors, by Vickers, 440 volts, 630 revs., with pulley.

Catalogue of Stock Machinery, 6,000 Lots.
Free on Application. Inspection Invited.

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ALBION WORKS,
SHEFFIELD.

20 H.P. Electric Motor, by Lancashire, 500 volts. D.C.; new 1916; with Brookhirst pillar control.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

WANTED, Furnace for Non-Ferrous; capacity about 400 lbs. State type and where same can be seen.—Box 286, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—New, or second-hand if in perfect condition, to equip a Foundry to turn out 20 tons of Iron Engine Castings per week, mostly hollow, between 5 and 200 lbs. in weight. Prices must be stated, sellers cannot be interviewed, and in the case of machines the maker's name should be given. Electric current available 500 volts D.C. Blower for Cupola, 3-4 tons per hour, blast inlet 14 in. bore. Hand Ladles, Two-man Ladles, Runway Ladle. Device for quickly adjusting height of runway ladles. 500 ft. of 3-in. turned Shafting with Couplings. 50—3-in. Roller Bearing Plummer Blocks. 4 Electric Motors, about 40 h.p., with starting switches. Sand-blast machines of barrel type, revolving type and cabin type, with dust extractor. Belt-driven Air Compressor to suit sand-blast plant. Pneumatic Chipping Hammers, Vibrators, Flexible Hose and Fittings. 1,000 ft. of 1½-in. Wrought Iron Pipe, with screw couplings. 2 Belt-driven Compressors, to suit pneumatic tools; about 200 ft. and 50 ft. per minute at 80 lbs. 3 Self-contained Core Ovens, gas or coke fired. 1,000 ft. of Runway Beam, to carry one ton over a span of 10 ft 10 Ball-bearing Runway Blocks. 10 one-ton geared Chain Blocks. 3,000 ft. Electric Cable 19-14, state maker and class. Mixers for Core Sand and Floor Sand. Paint Spraying Outfit for the rough painting of Castings.—THE BERGIUS LAUNCH AND ENGINE COMPANY, LIMITED, 254, Dobbie's Loan, Glasgow.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

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Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

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with the

QUALITY You are obtaining in **IRON &**
EXTRA PRICE You are paying for **STEEL**
DELIVERY You are getting of **CASTINGS.**

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JOHN GILLOTT & SON,

'Phone 446.
'Grams "Gillott Barnsley." *Dominion Works, Barnsley.*

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	10	0
Three months	64	5	0
Electrolytic	70	10	0
Tough	65	10	0
Best selected	65	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	69	17	6
Do. Nov.	69	17	6
Do. Dec.	69	17	6
Ingot bars	69	17	6
H.C. wire rods	74	15	0
Off. aver. cash, Oct.	62	16	5 2/3
Do. 3 mths., Oct.	63	8	11 1/11
Do. Settlement Oct.	62	15	10 10/11
Do. Electro, Oct.	71	0	0
Do. B.S., Oct.	66	11	1 1/3
Aver. spot price, copper, Oct.	62	15	4 3/4
Do. Electro, Oct.	71	5	11

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Sqnares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11½d
Brazed tubes 13½d
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

	£	s.	d.
Standard cash	184	15	6
Three Months	185	5	0
English	184	15	0
Bars	186	15	0
Chinese	183	15	0
Straits	186	2	6
Australian	185	15	0
Eastern	190	0	0
Banca	184	17	6
Off. aver. cash, Oct.	170	12	4 7/11
Do. 3 mths., Oct.	171	11	4 4/11
Do. Sttlment. Oct.	170	12	0 6/11
Aver. spot, Oct.	170	11	3

SPELTER.

	£	s.	d.
Ordinary	37	17	6
Remelted	34	10	0
Hard	27	15	0
Electro 99.9	39	0	0
English	37	15	0
India	28	15	0
Prime Western	37	15	0
Zinc dust	48	0	0
Zinc ashes	11	0	0
Off. aver., Oct.	34	0	6 3/22
Aver., spot, Oct.	34	11	4½

LEAD.

	£	s.	d.
Soft foreign ppt	26	10	0
English	27	10	0
Off. average, Oct.	25	1	3
Average spot, Oct.	25	11	3

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	40	0	0
Do. V.M. ex. whf.	40	10	0
Dutch	40	10	0
Rods	47	0	0
Boiler plates	39	0	0
Battery plates	39	10	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	10	0
Crude	18	10	0

QUICKSILVER.

Quicksilver £12 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
15/50% £11 2 6
75% £19 10 0
Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £24
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% 1/11 lb.
Ferro-chrome—
4/6% car. £22 5
6/8% car. £21 5
8/10% car. £20 10
Ferro-chrome—
Max. 2% car. £54 0
Max. 1% car. £65 0
Max. 0.70% car. £72 10
67/70%, carbonless 1/6½ lb.
Nickel—99%, cubes or pellets £137 10
Cobalt metal—98/99% 11/- lb.
Aluminium—98/99% £100
Metallic Chrominm—
96/98% 4/9 lb.
Ferro-manganese (net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10
Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Ronnds and sqnares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP

South Wales—	£	s.	d
Heavy Steel	3	10	0
Bundled steel & shearings	2	19	0
Mixed iron & steel	2	19	0
Heavy cast iron	3	10	0
Good machinery for foundries	4	0	0

Cleveland—	£	s.	d.
Heavy steel	3	8	0
Steel turnings	2	14	0
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	16	3
Cast-iron scrap	3	15	0

Lancashire—	£	s.	d.
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings	60	0	0
Braziery copper	48	0	0
Gun metal	42	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	92/6
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	93/9
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,,foundry No. 3	77/6 ,, 80/-
,, basic	80/-
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	105/-
,, No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	102/6
W.C. hematite	102/6 to 105/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	15	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	17	10	0

Steel—	£	s.	d.
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ¾in.	8	15	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1¼in.	8	5	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	15	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	12	15	0
Billets, soft	6 0 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bar	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gange

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	32.14
No. 2 foundry Valley	31.00
No. 2 foundry, Birm.	27.00
Basic	31.96
Bessemer	34.77
Malleable	33.96
Grey forge	32.27
Ferro-manganese 80 % delivered	—
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.90
Sheets, black, No. 28	3.50
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/- to 37/6
,, furnace 26/- to 27/6
Durham & North. foundry 30/-
,, furnace 27/-
Other Districts, foundry 30/-
,, furnace 26 -

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary—
Assortment .. £17 10 0 to £18 0 0

Nail Rods—
Square, round and flats ..

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents here.

TUBES.

		Up to and incl. 6 in.	
Gas	..	55%	Tube prices are now free.
Water	..	50%	
Steam	..	45%	

TINPLATES.

I.C.Cokes,	20×14, box		19/6
,,	28×20,	,,	39/–
,,	20×10,	,,	28/3
,,	18¾×14,	,,	20/1½
I.X.		,,	46/–
I.X.X.		,,	52/–
F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	34 9
I.C.W.	20×14,	,,	17/6
,,	28×20,	,,	35/–
,,	20×10,	,,	24/6
,,	18¾×14,	,,	18/–
Terneplates,	28×20,	,,	36/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	1	62	17	6	dec.	2/6
,,	2	62	15	0	,,	2/6
,,	3	62	12	6	,,	2 6
,,	6	63	5	0	inc.	12/6
,,	7	63	10	0	inc.	5/

Electrolytic Copper.

Nov.	1	70	5	0	No change	
,,	2	70	5	0	,,	
,,	3	70	0	0	dec.	5/–
,,	6	70	0	0	No change	
,,	7	70	10	0	inc.	10/–

Standard Tin (cash).

Nov.	1	180	5	0	dec.	75/–
,,	2	179	2	6	,,	22/6
,,	3	183	15	0	inc.	92/6
,,	6	187	7	6	,,	72/6
,,	7	184	15	0	dec.	52/6

Tin (English ingots)

Nov.	1	180	0	0	dec.	80/–
,,	2	179	0	0	dec.	20/–
,,	3	183	15	0	inc.	95/–
,,	6	187	10	0	,,	75/–
,,	7	184	15	0	dec.	55/–

Zinc Sheets (English).

Nov.	1	40	0	0	No change
,,	2	40	0	0	,,
,,	3	40	0	0	,,
,,	6	40	0	0	,,
,,	7	40	0	0	,,

Spelter (ordinary).

Nov.	1	37	5	0	dec.	5/–
,,	2	37	5	0	No change	
,,	3	37	10	0	inc.	5/–
,,	6	37	15	0	inc.	5/–
,,	7	37	17	6	inc.	2/6

Lead (English).

Nov.	1	27	10	0	dec.	10/–
,,	2	27	5	0	dec.	5/–
,,	3	27	5	0	No change	
,,	6	27	5	0	,,	
,,	7	27	10	0	inc.	5/–

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
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Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

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Telephone:— 11 Wellington, Salop. 5959 Central.

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Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Cold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

PRACTICAL CORE MAKER desires situation; wide and varied experience iron, steel and brass, motor, locomotive, textile and general engineering; 25 years at the trade, 10 years as Foreman, specialising in Oil, Sand, Plaster and Metal Core Box making, Sand Reclaiming, Machine and Hand Cores; progressive, up-to-date, possessing tact; used to control; skilled or semi-skilled labour; used to piece work; highest references.—Box No. 284, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

IRON, IN BAR SHEET AND WIRE.—Representative offers for South America, having extensive connections, desires to hear from interested concerns and submit proposals.—Write, C.S. 899, c/o Deacon's, Leadenhall Street, E.C.

WANTED.—One Foundry Foreman for heavy marine work and one for light castings and cylinders in Great Britain; McLain Graduates preferred.—State age, experience and salary first letter to McLain's System (Inc.), 710, Goldsmith Building, Milwaukee, Wis

WANTED, First-class Steel Foundry Manager; one who possesses initiative and can turn out sound castings up to 12-15 tons on economical lines; must be capable of reorganising existing foundry, and if necessary design and equip new one.—Give full particulars of career, qualifications, and salary expected, Box No. 290, Offices of the FOUNDRY TRADE JUORNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATENTS.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE Proprietor of the Patent No. 2,324 of 1912, for Improvements in Methods of Producing Wrought Shapes of Manganese Steel, is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed, in the first instance, to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE Proprietor of the Patent No. 1,479 of 1912, for Improvements Relating to the Manufacture of Manganese Steel, is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed, in the first instance, to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE Proprietor of British Patent No. 147931, dated April 8, 1916, relating to "METAL-HEATING FURNACES," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Woolworth Building, New York City, N.Y., U.S.A.

OWNER of protected secret alloy, light, strong and durable metal, thoroughly tested for bushes and highly recommended, would sell for lump sum or for sum and royalty.—Address, "ALLOY," Wm. Porteous & Company, Advertising Agents, Glasgow.

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WANTED to purchase an interest in up-to-date Steel Foundry, capable of handling up to 10 tions.—Box No. 288, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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Five Lancashire Boilers, 30 ft. x 8 ft., new in 1917. reinsure 100 lbs. working pressure. Two nearly-new steel Lancashire Boilers, 30 ft. x 9 ft., reinsureable at 100 lbs. working steam pressure, complete with steam and furnace fittings, etc.; ready for immediate loading; cheap for quick sale. Three Lancashire Boilers 30 ft. x 7 ft. 6 in., now insured at 150 lbs. pressure. Four Marine Water Tube Boilers, by Yarrow, Limited, each 4,000 sq. ft. heating surface, reinsure 200 lbs. pressure. One Vertical Boiler, 6 ft. 6 in. x 3 ft 9 in. diameter, reinsure 80 lbs. pressure. Air Receivers. 6 ft. x 2 ft. 6 in., tested to 90 lbs. pressure, with safety valve, drain cock, etc. Two Open Top Cisterns, each 11 ft. x 8 ft. x 5 ft. 4 in. deep, plates about ½ in. thick, capacity about 2,885 gallons each.

Catalogue of Stock Machinery, 6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

20 H.P. Electric Motor, by Lancashire, 500 volts. D.C.; new 1916; with Brookhirst pillar control.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

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WANTED.—MOULDING MACHINE, preferably "Tabor" type, if possible including Compressor; must be in running condition and cheap; London area preferred.—Full details to Box No. 282, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

BLAST FANS.—8 Electric Fans, totally enclosed Aston Motors, by Verity's, Limited, 100 v. 16.3 amps., D.C. 1.6 h.p. Sirocco Fans, 22 in. dia., inlet 15 in. and outlet 8 in. square; condition nearly new; £10 each.—MACHINERY TRADING COMPANY, LIMITED, Ballast Quay, Poole.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

FOUNDRY PLANT FOR SALE.

Hand Moulding Machines.

TWO "Coventry" Head Ram Machines, by Britannia Foundry Company .. .. each	£25
TWO Evans Flypress Type Squeezers, for 13 in. x 13 in. boxes .. .. each	£12
FOUR Turnover Machines, by Phillips, for 16 in. x 14 in. boxes .. .. each	£14
ONE Pridmore Rockover Drop Machine, for 20 in. x 14 in. boxes	£40
ONE Darling & Sellars Machine, Turnover Type, for 36 in. x 24 in. boxes	£30
TWO Darling & Sellars Machine, Turnover Type, for 20 in. x 16 in. boxes .. .. each	£25

Furnaces.

30 in. ALLDAYS Cupola, with lining bricks and Hood	£50
No. 1 GREEN'S Cupolette, with 480 Volt Electric Fan, etc.	£35
Blowers and Fans to suit IN STOCK.	
SIX Morgan "S" Type 600-lb. coke-fired Tilting Furnaces .. .. each	£70
TWO Wright-Morgan "S" Type 300-lb. gasfired Tilting Furnaces .. .. each	£40
TWO Jackman 300-lb. Furnaces, split, open like book .. .. each	£20

Ladles.

20-Ton Steel Ladle, Brand New	£220
4-Ton Steel Ladle, by Stevenson, NEW	£65
10-cwt. Evans Crane Ladle, not geared	£12
4 NEW 2-cwt. Shanks .. .. each	£4
3 NEW 1-cwt. Shanks .. .. each	£3
4 NEW Hand Ladles .. .. each	15s.

Ladle Carriers, Crucible Tongs, etc., of all descriptions in stock. Please send enquiries.

ALEX. HAMMOND, *Foundry Machinery Merchant,* **BOXTED, SLOUGH.**

To THE EDITOR of the Foundry Trade Journal.

Please send me details of the visit to the International Foundry Trade Congress and Exhibition to be held in Paris next September.

Name.....

Address.....

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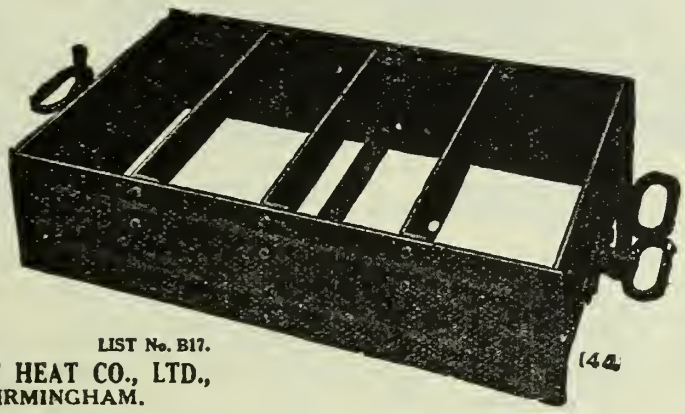
'Phone: Smethwick 276.

3,000 SIZES.



RIGID, UNBREAKABLE.

Telegrams: "Repeat, Birmingham."

IMMEDIATE DELIVERY.

LIST No. B17.

THE INCANDESCENT HEAT CO., LTD., Smethwick, BIRMINGHAM.

For Wood, Metal or Plate

PATTERNS

(Large or small)

send to

FURMSTON & LAWLOR

Engineers' Pattern Makers,

BIRDS HILL, LETCHWORTH.

Telephone 185.

S. J. BURRELL PRIOR, LTD.,

Equitable House,

47-51, KING WILLIAM STREET, LONDON, E.C.

TIN PLATES,

BLACK PLATES,

ROUND & RECTANGULAR PLATES,

For Enamelling and Deep Stamping.

Telegrams: "PRIOR, LONDON."

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash.. ..	63	7	6
Three months.. ..	64	5	0
Electrolytic	70	15	0
Tongh	65	10	0
Best selected	65	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	10	0
Do. Nov.	70	10	0
Do. Dec.	70	10	0
Ingot bars	70	10	0
H.C. wire rods.. ..	74	15	0
Off. aver. cash, Oct.	62	16	$5\frac{1}{2}$
Do. 3 mths., Oct.	63	8	$11\frac{8}{11}$
Do. Settlement Oct.	62	15	$10\frac{10}{11}$
Do. Electro, Oct.	71	0	0
Do. B.S., Oct. ..	66	11	$1\frac{1}{3}$
Aver. spot price, copper, Oct. ..	62	15	$4\frac{3}{4}$
Do. Electro, Oct.	71	5	11

Solid drawn tubes .. $13\frac{1}{2}$d.
Brazed tubes .. .. $13\frac{1}{2}$d.
Wire .. .. .. $10\frac{1}{2}$d.
Yellow metal rods.. $6\frac{3}{4}$d.
Do. 4x4 Squares .. $8\frac{1}{4}$d.
Do. 4x3 Sheets .. $9\frac{1}{4}$d

BRASS.

Solid drawn tnbes.. $11\frac{1}{2}$d.
Brazed tubes .. .. $13\frac{1}{4}$d
Rods, drawn . .. $10\frac{3}{4}$d.
Rods, extruded or rolled $6\frac{1}{2}$d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. $9\frac{1}{4}$d.
Rolled metal .. $9\frac{1}{2}$d.

TIN.

Standard cash ..	180	0	0
Three Months ..	180	17	6
English	180	0	0
Bars	182	0	0
Chinese	179	0	0
Straits	181	12	6
Australian	181	10	0
Eastern	186	0	0
Banca	180	2	6
Off. aver. cash, Oct.	170	12	$4\frac{7}{11}$
Do. 3 mths., Oct.	171	11	$4\frac{4}{11}$
Do. Sttlment Oct.	170	12	$0\frac{6}{11}$
Aver. spot, Oct...	170	11	3

SPELTER.

Ordinary	38	17	6
Remelted	35	0	0
Hard	28	0	0
Electro 99.9	40	15	0
English	39	2	6
India	29	0	0
Prime Western ..	39	2	6
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Oct. ..	34	0	$6\frac{3}{12}$
Aver., spot, Oct. ..	34	11	$4\frac{1}{2}$

LEAD.

Soft foreign ppt ..	26	12	6
English..	27	10	0
Off. average, Oct.	25	1	3
Average spot, Oct.	25	11	3

ZINC SHEETS.

Zinc sheets, English	41	0	0
Do. V.M. ex. whf	42	0	0
Dntch	42	0	0
Rods	49	0	0
Boiler plates	40	10	0
Battery plates ..	42	10	0

ANTIMONY.

English regulus ..	27	0	0
Special brands ..	33	10	0
Chinese	25	5	0
Crude	17	10	0

QUICKSILVER.

Quicksilver 12 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 11 2 6
¼ 19 10 0
Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £24
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% .. .. 1/11 lb.
Ferro-chrome—
4/6% car. £21 15
6/8% car. .. £20 15
8/10% car. .. £20 0
Ferro-chrome—
Max. 2% car. .. £54 0
Max. 1% car. .. £65 0
Max. 0.70% car. .. £72 10
67/70%, carbonless 1/7 lb.
Nickel—99%, cubes or pellets .. £137 10
Cobalt metal—98/99% 11/- lb.
Aluminium—98/99% £100
Metallic Chrominm—
96/98% .. .. 4/9 lh.
Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese—
94/96%, carhonless 2/3 lh.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. 2 d. 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and sqnares 3 in. to 8 in. inclusive 4d. lb.
Rounds and sqnares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cnt to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	3	0	0	3	15	0
Mixed iron & steel	2	19	0	3	3	6
Heavy cast iron ..	3	10	0	3	15	0
Good machinery for foundries	3	15	0	4	0	0
Cleveland—						
Heavy steel ..	3	8	0			
Steel turnings ..	2	14	0			
Cast-iron borings	2	12	6			
Heavy forge ..	3	12	6			
Bushelled scrap..	2	16	3			
Cast-iron scrap ..	3	15	0			
Lancashire—						
Cast iron scrap ..	3	17	6			
Heavy wrought ..	3	7	6			
Steel turnings ..	2	2	6			
London—	£	s.	d.			
Copper (clean) ..	56	0	0			
Brass (clean) ..	32	0	0			
Lead (less usual draft)	22	0	0			
Tea lead	20	0	0			
Zinc	22	10	0			
New aluminium cuttings ..	60	0	0			
Braziery copper ..	48	0	0			
Gun metal ..	42	0	0			
Hollow pewter ..	130	0	0			
Shaped black pewter	90	0	0			

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1 ..	97/6
Foundry No. 3 ..	92/6
Forge No. 4	85/-
Mottled	82/6
Hematite No. 1 ..	93/9
Hematite M/Nos. ..	93/-
Midlands—	
Staffs. common ..	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	180/- 200/-
,, basic	—
Northants forge	70/- to 72/6
,,foundry No. 3	77/6 ,, 80/-
,, basic.. ..	80/-
Derbyshire forge ..	75/-
,, foundry No. 3	82/6
,, basic ..	80/-
Scotland—	
Foundry No. 1 ..	104/-
,, No. 3 ..	99/-
Hematite M/Nos. ..	107/6
Sheffield (d/d district)—	
Derby forge	85/6
,, foundry No. 3	87/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite ..	102/6
W.C. hematite	105/-
All d/d in the district.	
Lancashire (d/d eq. Man.) —	
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry..	115/6
Glengarnock foundry	117/6
Gartsherrie foundry	117/6
Monkland foundry ..	115/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins...	£11 to £12		
Nut and bolt ..	9	12	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	17	0	0
Steel—			
Ship plates	£9 to 9	10	0
Boiler plates ..	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in...	9	15	0
Rounds, under 3in. to ⅝in. ..	8	15	0
Flats, over 5in. wide and up..	9	15	0
Flats 5in. to 1¼in.	8	5	0
Rails, heavy ..	8	15	0
Fishplates ..	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	16	15	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ¾ in. dia	12	15	0
Billets, soft	6 0 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bars	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 $3\frac{1}{2}$
Wire	1 $3\frac{1}{2}$
Rods	1 $2\frac{1}{2}$
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire round—	
3/0 to 10. G. ..	1/8½ to 2/3½

with extras according to gange

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	32.14
No. 2 fonndry Valley..	31.00
No. 2 foundry, Birm. ..	27.00
Basic	31.96
Bessemer	34.77
Malleable	33.96
Grey forge	32.27
Ferro-manganese 80 % delivered	—
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Boss. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars ..	40.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.90
Sheets, black, No. 28 ..	3.50
Sheets, galv., No. 28 ..	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv. ..	3.35
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry.. ..	35/-
,, furnace	26/-
Durham & North fdr.	27/6 to 30/-
,, furnace	22/6 to 25/6
Other Districts, foundry	25/- to 30/-
,, furnace	21/6 to 24/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	18 0 0 to 18 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.
Gas ..	57½%
Water ..	5. ½%
Steam ..	47½%

Tube prices are now free.

TINPLATES.

I.C. Cokes,	20×14, box	19/6
,,	28×20, ,,	39/–
,,	20×10, ,,	28/9
,,	18¾×14, ,,	20/1½
I.X.	,,	46/–
I.X.X.	,,	52/–
F.C.B.Y.	21×13⅝ ,,	36/6
C.V.B.G.	16¾×15, ,,	34 9
I.C.W.	20×14, ,,	17/7½
,,	28×20, ,,	35/3
,,	20×10, ,,	25/7½
,,	18¾×14, ,,	18 4½
Terneplates,	28×20, ,,	36/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Nov. 8	63	2	6	dec.	7/6
,, 9	63	5	0	inc.	2/6
,, 10	63	12	6	,,	7/6
,, 13	63	15	0	,,	2/6
,, 14	63	7	6	dec.	7/6

Electrolytic Copper.

Nov. 8	70	10	0	No change	
,, 9	70	10	0	,,	
,, 10	70	10	0	,,	
,, 13	70	15	0	inc.	5/–
,, 14	70	15	0	No change	

Standard Tin (cash).

Nov. 8	180	17	6	dec.	77/6
,, 9	184	10	0	inc.	72/6
,, 10	184	5	0	dec.	5/–
,, 13	182	7	6	,,	37/6
,, 14	180	0	0	,,	47/6

Tin (English ingots)

Nov. 8	181	0	0	dec.	75/–
,, 9	184	10	0	inc.	70/–
,, 10	184	5	0	dec.	5/–
,, 13	182	10	0	,,	35/–
,, 14	180	0	0	dec.	50/–

Zinc Sheets (English).

Nov. 8	40	0	0	No change	
,, 9	40	0	0	,,	
,, 10	41	0	0	inc.	20/–
,, 13	41	0	0	No change	
,, 14	41	0	0	,,	

Spelter (ordinary).

Nov. 8	38	5	0	inc.	7/6
,, 9	38	17	6	,,	12/6
,, 10	39	2	6	,,	5/–
,, 13	39	2	6	No change	
,, 14	38	17	6	dec.	5/–

Lead (English).

Nov. 8	27	15	0	inc.	5/–
,, 9	27	15	0	No change	
,, 10	27	15	0	,,	
,, 13	27	10	0	dec.	5/–
,, 14	27	10	0	No change	

There's something for You among these

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

WANTED, FOREMAN for small Foundry, close London. Light, cast iron and semi-steel, state age, experience, and salary, Box 296, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—Metallurgist for large Industrial Plant; must be conversant with the latest methods of heat treatment tempering and case hardening of steel; applicants should state qualifications, experience, past and present employers, which will be treated confidentially. — Address, "Metallurgist," WM. PORTEOUS & COMPANY, Advertising Agents, Glasgow.

FOUNDRY FOREMAN wanted for London district; must have good knowledge of general machine castings, also thoroughly understands mixture of metals; no one unless thoroughly experienced need apply.—Reply, stating wage required, to Box 294, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

SALE BY AUCTION.

By order of the Senior Official Receiver in Companies Liquidation in the Matter of the Dreadnought Portland Cement Company, Limited (in Liquidation).

BARRINGTON,
near CAMBRIDGE,
1½ mile from Foxton Station, G.E.R., and six miles from Cambridge.

SALE of
the valuable FREEHOLD PROPERTY
known as
THE DREADNOUGHT PORTLAND CEMENT WORKS,
comprising
ABOUT 150 ACRES of valuable MINERAL-BEARING LAND, eminently suitable for the manufacture of Portland cement,
with the substantially-built
POWER HOUSE, BOILER HOUSE, CHIMNEY SHAFT 150 ft. high,
concrete raft, brick wall, offices, mess house, lime kiln, farm buildings, and artesian well thereon.

The desirable FREEHOLD RESIDENCE,
built for the manager,
containing three sitting rooms, six bed rooms, bath (h. and c.), and good domestic offices, garage, and garden, the whole having an area of two acres.

The valuable RAILWAY SIDING,
about 1¼ mile in length,
connecting the works with the Great Eastern line (Cambridge branch) at Foxton Station, together with the land over which it runs, comprising an area of about 19 acres, and the whole of the
VALUABLE RAILWAY MATERIALS,
of which it is constructed, consisting of approximately 14,900 ft. of 75-lb. steel rail, 7,760 ft. of 6-strand galvanised wire fencing with reinforced concrete posts, bridge with iron girders, and a large quantity of sleepers, dogs, switches, points, slag, etc.

Possession of the whole, including the manager's house, will be given on completion.

The attention of Cement Manufacturers, Builders, Steel Manufacturers, and Speculators is directed to this sale, as affording a great opportunity for enterprise in the future.

The property only requires the installation of machinery to make it a going concern, as most of the spade-work has already been accomplished.

To be SOLD by AUCTION,
IN ONE LOT,
and if not sold, offered separately, by
MR. WILLIAM YOUNG
(in conjunction with Messrs. ROBINSON & ROODS),
at WINCHESTER HOUSE, OLD BROAD STREET, London, E.C. (Room 23),
on MONDAY, November 27, 1922,
at three o'clock precisely,

Particulars and plans and conditions of sale may be obtained of Messrs. Lawrance, Webster, Messer, and Nicholls, Solicitors, 14, Old Jewry Chambers, E.C.2; Messrs. Robinson & Roods, Surveyors, 37, Bedford Row, W.C.1; and of Mr. William Young, Auctioneer, 4, St. Peter's Street, St. Albans, Herts.

PATENTS.—*Cont.*

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE Proprietor of British Patent No. 147931, dated April 8, 1916, relating to "METAL-HEATING FURNACES," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Woolworth Building, New York City, N.Y., U.S.A.

THE PROPRIETOR of the Patent No. 138900 for Bessemerizing iron is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

TENDER.

GLASGOW CORPORATION TRAMWAYS.
STEEL RAILS AND FISHPLATES.

THE CORPORATION OF GLASGOW are prepared to receive TENDERS for the SUPPLY of the undernoted :—

2,500/3,000 Tons Steel Rails, B.S. Section No. 8.
500 Tons Fishplates for above.
1,200 Tons Special Section 5-in. Rail.
21 Tons Fishplates for above.

Specifications, Forms of Tender, and Drawings can be obtained on application to Mr. James Dalrymple, General Manager, 46, Bath Street. Sealed Tenders, marked outside "TRAMWAYS—TENDER FOR STEEL RAILS," must be lodged with the Subscriber on or before TUESDAY, 28th NOVEMBER current.

The lowest or any Tender may not be accepted.

J. LINDSAY, Town Clerk.
City Chambers, 14th November, 1922.

AGENCIES.

FRENCH MERCHANT in the manufacturing centre for Boot Laces and other, requires English Manufacturer who would give the exclusivity for the sale of white iron and black varnished Taglaces, 1/10th of m/m. thick, for Lace tagging.—Apply to No. 3,677 Agence Havas, Lyon, France.

AGENCY for Non-Ferrous Metals desired by Sheffield firm; good connection in Iron and Steel and Brass Trades.—Box 292, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.

20 H.P. Electric Motor, by Lancashire, 500 volts, D.C.; new 1916; with Brookhirst pillar control.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

FOUNDRY PLANT FOR SALE.

Hand Moulding Machines.

TWO "Coventry" Head Ram Machines, by Britannia Foundry Company .. .. each £25
TWO Evans Flypress Type Squeezers, for 13 in. x 13 in. boxes .. .. each £12
FOUR Turnover Machines, by Phillipe, for 16 in. x 14 in. boxes .. .. each £14
ONE Pridmore Rockover Drop Machine, for 20 in. x 14 in. boxes £40
ONE Darling & Sellars Machine, Turnover Type, for 36 in. x 24 in. boxes £30
TWO Darling & Sellars Machine, Turnover Type, for 20 in. x 16 in. boxes .. .. each £25

Furnaces.

30 in. ALLDAYS Cupola, with lining bricks and Hood £50
No. 1 GREEN'S Cupolette, with 480 Volt Electric Fan, etc. £35
Blowers and Fans to suit IN STOCK.
SIX Morgan "S" Type 600-lb. coke-fired Tilting Furnaces .. .. each £70
TWO Wright-Morgan "S" Type 300-lb. gasfired Tilting Furnaces .. .. each £40
TWO Jackman 300-lb. Furnaces, split, open like book .. .. each £20

Ladles.

20-Ton Steel Ladle, Brand New £220
4-Ton Steel Ladle, by Stevenson, NEW £65
10-cwt. Evans Crane Ladle, not geared £12
4 NEW 2-cwt. Shanks .. .. each £4
3 NEW 1-cwt. Shanks .. .. each £3
4 NEW Hand Ladles .. .. each 15s.
Ladle Carriers, Crucible Tongs, etc., of all descriptions in stock. Please send enquiries.

ALEX. HAMMOND, *Foundry Machinery Merchant,* **BOXTED, SLOUGH.**

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	17	6
Three months	63	15	0
Electrolytic	70	10	0
Tough	66	0	0
Best selected	66	0	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	12	6
Do. Dec.	70	12	6
Do. Jan.	70	12	6
Ingot bars	70	12	6
H.C. wire rods	75	0	0
Off. aver. cash, Oct.	62	16	$5\frac{1}{22}$
Do. 3 mths., Oct.	63	8	$11\frac{5}{11}$
Do. Settlement Oct.	62	15	$10\frac{10}{11}$
Do. Electro, Oct.	71	0	0
Do. B.S., Oct. ..	66	11	$1\frac{1}{3}$
Aver. spot price, copper, Oct. ..	62	15	$4\frac{3}{4}$
Do. Electro, Oct.	71	5	11

Solid drawn tubes ..	$13\frac{1}{2}$d.
Brazed tubes	$13\frac{1}{2}$d.
Wire	$10\frac{1}{2}$d.
Yellow metal rods ..	$6\frac{1}{2}$d.
Do. 4x4 Sqnares ..	$8\frac{1}{4}$d.
Do. 4x3 Sheets ..	$9\frac{1}{4}$d

BRASS.

Solid drawn tubes ..	$11\frac{1}{2}$d.
Brazed tubes	$13\frac{1}{2}$d
Rods, drawn	$10\frac{3}{4}$d.
Rods, extruded or rolled	$6\frac{1}{2}$d.
Sheets to 10 w.g. ..	10d.
Wire	$9\frac{1}{4}$d.
Rolled metal ..	$9\frac{1}{2}$d.

TIN.

	£	s	d.
Standard cash ..	178	0	0
Three Months ..	178	15	0
English	178	0	0
Bars	180	0	0
Chinese	177	0	0
Straits	179	15	0
Australian	179	10	0
Eastern	182	0	0
Banca	178	5	0
Off. aver., cash, Oct.	170	12	$4\frac{7}{11}$
Do. 3 mths., Oct.	171	11	$4\frac{4}{11}$
Do. Sttlment. Oct.	170	12	$0\frac{6}{11}$
Aver. spot, Oct. ..	170	11	3

SPELTER.

	£	s	d.
Ordinary	37	15	0
Remelted	34	0	0
Hard	27	10	0
Electro 99.9	40	10	0
English	38	10	0
India	28	10	0
Prime Western ..	38	7	6
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Oct. ..	34	0	$6\frac{3}{22}$
Aver., spot, Oct. ..	34	11	$4\frac{1}{2}$

LEAD.

	£	s	d.
Soft foreign ppt ..	26	10	0
English	27	10	0
Off. average, Oct.	25	1	3
Average spot, Oct.	25	11	3

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	41	10	0
Do. V.M. ex. whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	40	10	0
Battery plates ..	42	10	0

ANTIMONY.

	£	s	d.
English regulus ..	27	0	0
Special brands ..	33	10	0
Chinese	25	5	0
Crude	17	10	0

QUICKSILVER.

	£	s	d.
Quicksilver	12	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	11 6 0
75%	19 10 0
Ferro-vanadium— 35/40%	17/- lb. va.
Ferro-molybdenum— 70/75% c. free	9/6 lb. mo.
Ferro-titanium— 23/25%, carbonless	1/2 lb.
Ferro-phosphorus, 20/23%,	£24
Ferro-tungsten— 80/85%, carbon free	1/5 lb.
Tungsten metal powder— 98/99%	1/11 lb.
Ferro-chrome— 4/6% car.	£22 5
6/8% car. ..	£21 5
8/10% car. ..	£20 10
Ferro-chrome— Max. 2% car. ..	£54 0
Max. 1% car. ..	£65 0
Max. 0.70% car. ..	£72 10
67/70%, carbonless	$1/6\frac{1}{2}$ lb.
Nickel—99%, cubes or pellets ..	£137 10
Cobalt metal—98/99%	11/3 lb.
Aluminium—98/99%	£100
Metallic Chrominm— 96/98%	4/9 lb.
Ferro-manganese(net)— 76/80%, loose ..	£15
76/80%, packed ..	£16
76/80%, export ..	£14 10
Metallic manganese— 94/96%, carbonless	2/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s. d.
Finished bars, 14% tungsten	2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under $\frac{1}{2}$ in. to $\frac{1}{4}$ in. 3d. lb,
Flats under 1 in. by $\frac{5}{8}$ in. to $\frac{1}{2}$ in. by $\frac{1}{4}$ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d	£	s.	d
Heavy Steel	3	12	6	3	17	6
Bundled steel & shearings	3	0	0	3	15	0
Mixed iron & steel ..	3	0	0	3	7	6
Heavy cast iron ..	3	10	0	3	15	0
Good machinery for foundries	3	15	0	4	0	0

Cleveland—			
Heavy steel ..	3	8	0
Steel turnings ..	2	14	0
Cast-iron borings	2	12	6
Heavy forge ..	3	12	6
Bushelled scrap ..	2	16	3
Cast-iron scrap ..	3	15	0

Lancashire—			
Cast iron scrap ..	3	16	3
Heavy wrought ..	3	2	6
Steel turnings ..	2	2	6

London—	£	s.	d.
Copper (clean) ..	56	0	0
Brass (clean) ..	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings ..	60	0	0
Braziery copper ..	48	0	0
Gun metal ..	42	0	0
Hollow pewter ..	130	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1 ..	97/6
Foundry No. 3 ..	92/6
Forge No. 4	85/-
Mottled	81/6
Hematite No. 1 ..	93/9
Hematite M/Nos. ..	93/-
Midlands—	
Staffs. common ..	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast	180/- 200/-
,, basic	—
Northants forge	70/- to 72/6
,,foundry No. 3	77/6 ,, 80/-
,, basic.. ..	80/-
Derbyshire forge ..	75/-
,, foundry No. 3	82/6
,, basic ..	80/-
Scotland—	
Foundry No. 1 ..	101/6
,, No. 3 ..	96/6
Hematite M/Nos. ..	107/6
Sheffield (d/d district)—	
Derby forge	85/6
,, foundry No. 3	87/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite ..	102/6
W.C. hematite	105/-

All d/d in the district.

Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Clevoland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry ..	114/6
Glengarnock foundry	116/6
Gartsherrie foundry	116/6
Monkland fonndry ..	114/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins...	£11 to £12		
Nut and bolt ..	9	12	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, $\frac{3}{4}$ in. × 4 in.	17	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates ..	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in...	9	5	0
Rounds, under 3in. to ⅝in. ..	8	15	0
Flats, over 5in. wide and up..	9	10	0
Flats 5in. to 1¼in.	8	15	0
Rails, heavy ..	8	15	0
Fishplates ..	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	0	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	6 0 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bars	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 $3\frac{1}{2}$
Wire	1 $3\frac{1}{2}$
Rods	1 $2\frac{1}{2}$
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire ronnd— 3/0 to 10. G. ..	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	31.14
No. 2 foundry Valley ..	29.00
No. 2 foundry, Birm. ..	25.00
Basic	30.96
Bessemer	34.27
Malleable	31.96
Grey forge	30.77
Ferro-manganese 80 % delivered	—
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars ..	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.90
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv. ..	3.35
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry	35/-
,, furnace	26/-
Durham & North. fdy.	27/6 to 30/-
,, furnace	22/6 to 25,6
Other Districts, foundry	25/- to 30/-
,, ,, furnace	21/6 to 24/6

SWEDISH IRON.

Bars, hammered basis sizes	Basis price £22 to £23		
Rolled Ordinary— Assortment ..	£ 18	s. 0	d. 0
Nail Rods— Square, round and flats ..	to 18	10	0
Keg Steel	nom. £38 to £40		
Faggot Steel	nom. £30 to £32		
Blooms— Single welded ..	£10 to £11		
Billets— Single and double welded	£13 to £14		
Pig-Iron— Grey, white or mottled ..	£7 to £7 10 0		

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	57½%	Tube prices are now free.
Water	52½%	
Steam	47½%	

TINPLATES.

I.C.Cokes,	20×14, box		19/6
,,	28×20,	,,	40/-
,,	20×10,	,,	28/9
,,	18¾×14,	,,	20/1½
I.X.		,,	46/-
I.X.X.		,,	52/-
F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	34 9
I.C.W.	20×14,	,,	17/10½
,,	28×20,	,,	35/6
,,	20×10,	,,	24/10½
,,	18¾×14,	,,	18/4½
Terneplates,	28×20,	,,	36/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d	
Nov. 15	63	7	6	No change
,, 16	63	5	0	dec. 2/6
,, 17	63	7	6	inc 2/6
,, 20	63	5	0	dec. 2/6
,, 21	62	17	6	,, 7/6

Electrolytic Copper.

Nov. 15	70	15	0	No change
,, 16	70	15	0	,,
,, 17	70	15	0	,,
,, 20	70	15	0	,,
,, 21	70	10	0	dec. 5/-

Standard Tin (cash).

Nov. 15	182	5	0	inc. 45/-
,, 16	178	10	0	dec. 75/-
,, 17	177	10	0	,, 20/-
,, 20	178	7	6	inc. 17/6
,, 21	178	0	0	dec. 7/6

Tin (English ingots)

Nov. 15	182	5	0	inc. 45/-
,, 16	178	10	0	dec. 75/-
,, 17	177	10	0	,, 20/-
,, 20	178	10	0	inc. 20/-
,, 21	178	0	0	dec. 10/-

Zinc Sheets (English)

Nov. 15	41	10	0	inc. 10/-
,, 16	41	10	0	No change
,, 17	41	10	0	,,
,, 20	41	10	0	,,
,, 21	41	10	0	,,

Spelter (ordinary).

Nov. 15	39	0	0	inc. 2/6
,, 16	39	2	6	,, 2/6
,, 17	39	5	0	,, 2/6
,, 20	38	7	6	dec. 17/6
,, 21	37	15	0	,, 12/6

Lead (English).

Nov. 15	27	10	0	No change
,, 16	27	5	0	dec. 5/-
,, 17	27	5	0	No change
,, 20	27	5	0	,,
,, 21	27	10	0	inc. 5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London:—10, Push Lane, Cannon St. E.C.4.

Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEED, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

FOUNDRY Metalurgist and Chemist, M.Inst.B.F., desires responsible position, control of Cupolas and Laboratory; Birmingham district preferred. Experience: Melting of Grey iron, "Semi-steel," also Brass, Gunmetal, Aluminium alloys; good organiser; excellent refcrences.—Apply, Box 302, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

FOUNDRY FOREMAN wanted for London district; must have good knowledge of general machine castings, also thoroughly understands mixture of metals; no one unless thoroughly experienced need apply.—Reply, stating wage required, to Box 294. Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, FOREMAN for small Foundry, close London. Light, cast iron and semi-steel. state age, experience, and salary, Box 296, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5. Duke Street, Adelphi, London, W.C.2.

WANTED.—Metallurgist for large Industrial Plant; must be conversant with the latest methods of heat treatment tempering and case hardening of steel; applicants should state qualifications, experience, past and present employers, which will be treated confidentially. — Address, "Metallurgist," WM. PORTEOUS & COMPANY, Advertising Agents, Glasgow.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

TENDER.

GLASGOW CORPORATION TRAMWAYS.
STEEL RAILS AND FISHPLATES.

THE CORPORATION OF GLASGOW are prepared to receive TENDERS for the SUPPLY of the undernoted :—

2,500/3,000 Tons Steel Rails, B.S. Section No. 8.
500 Tons Fishplates for above.
1,200 Tons Special Section 5-in. Rail.
21 Tons Fishplates for above.

Specifications, Forms of Tender, and Drawings can be obtained on application to Mr. James Dalrymple, General Manager, 46, Bath Street. Sealed Tenders, marked outside "TRAMWAYS—TENDER FOR STEEL RAILS." must be lodged with the Subscriber on or before TUESDAY, 28th NOVEMBER current.

The lowest or any Tender may not be accepted.

J. LINDSAY, Town Clerk.

City Chambers, 14th November, 1922.

PATENT.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE PROPRIETOR of the Patent No. 138900 for Bessemerizing iron is desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE Proprietor of British Patent No. 147931, dated April 8, 1916, relating to "METAL-HEATING FURNACES," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Woolworth Building, New York City, N.Y., U.S.A.

AGENCIES.

AGENCY for Non-Ferrous Metals desired by Sheffield firm; good connection in Iron and Steel and Brass Trades.—Box 292, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

SALE BY AUCTION.

By order of the Senior Official Receiver in Companies Liquidation in the Matter of the Dreadnought Portland Cement Company, Limited (in Liquidation).

BARRINGTON,
near CAMBRIDGE,
1½ mile from Foxton Station, G.E.R., and six miles from Cambridge.

SALE of
the valuable FREEHOLD PROPERTY
known as
THE DREADNOUGHT PORTLAND CEMENT WORKS,
comprising
ABOUT 150 ACRES of valuable MINERAL-BEARING LAND, eminently suitable for the manufacture of Portland cement,
with the substantially-built
POWER HOUSE, BOILER HOUSE, CHIMNEY SHAFT 150 ft. high,
concretc raft, brick wall, offices, mess house, lime kiln, farm buildings, and artesian well thereon.

The desirable FREEHOLD RESIDENCE,
built for the manager,
containing three sitting rooms, six bed rooms, bath (h. and c.), and good domestic offices, garage, and garden, the whole having an area of two acres.

The valuable RAILWAY SIDING.
about 1¼ mile in length,
connecting the works with the Great Eastern line (Cambridge branch) at Foxton Station, together with the land over which it runs, comprising an area of about 19 acres, and the whole of the
VALUABLE RAILWAY MATERIALS,
of which it is constructed, consisting of approximately 14,900 ft. of 75-lb. steel rail, 7,760 ft. of 6-strand galvanised wire fencing with reinforced concrete posts. bridge with iron girders, and a large quantity of sleepers, dogs, switches, points, slag, etc.

Possession of the whole, including the manager's house, will be given on completion.

The attention of Cement Manufacturers, Builders. Steel Manufacturers, and Speculators is directed to this sale, as affording a great opportunity for enterprise in the future.

The property only requires the installation of machinery to make it a going concern, as most of the spade-work has already been accomplished.

To be SOLD by AUCTION,
IN ONE LOT,
and if not sold, offered separately, by
MR. WILLIAM YOUNG
(in conjunction with Messrs. ROBINSON & ROODS),
at WINCHESTER HOUSE, OLD BROAD STREET, London, E.C. (Room 23),
on MONDAY, November 27, 1922,
at three o'clock precisely,

Particulars and plans and conditions of sale may be obtained of Messrs. Lawrance, Webster, Messer, and Nicholls, Solicitors, 14, Old Jewry Chambers, E.C.2: Messrs. Robinson & Roods, Surveyors, 37, Bedford Row, W.C.1; and of Mr. William Young, Auctioneer, 4, St. Peter's Street, St. Albans, Herts.

MACHINERY.

6-Wheel Coupled Saddle Tank Locomotive (Manning Wardles), with inside cyls., 12 in. diam. x 18 in. stroke, 4 ft. 8½ in. gauge, 140 lbs. W.P., sale or hire. 3-ton "Grafton" Loco. Steam Crane, with 27 ft. 6 in. steel latticed jib, all motions by steam, 4 ft. 8½ in. gauge, boiler for 70 lbs. W.P. New 3-ton Hand Derrick Crane, with 45 ft. timber jib, two wire ropes. Portable 6 ft. Mortar Mill, with Engine and Boiler, having steel girder carriage with flat-faced road wheels. 9 ft. Perforated Grinding Mill, over-driven, with gathering-up pan underneath, grids with 3 in. x 1/16 in. slots. 20 in. x 9 in. Stone Breaker (Goodwin-Barsby), having "Era" manganese steel jaws. 3-ton "Avery" Dormant Weighing Machine, with platform 5 ft. x 4 ft., fitted with F.B. rails 2 ft. gauge.

Catalogue of Stock Machinery, 6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

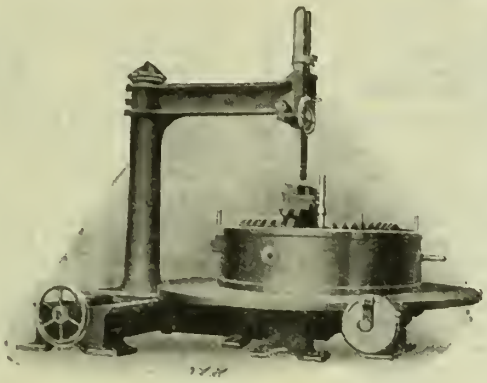


TABLE MOULDING MACHINE

JACKSON & BROTHER, LTD.,
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Telephone : 34 Bolton.
BOLTON.

WHEEL MOULDING MACHINES
For SPUR, BEVIL, STRAIGHT & DOUBLE HELICAL WHEELS.
MACHINE IS PROVIDED WITH
SCOTT DIVIDING APPARATUS AND
REQUIRES NO CHANGE WHEELS.
We also make
A FLOOR or PILLAR WHEEL MOULDING MACHINE
With your enquiry state the maximum diameter you wish to make.
LARGE NUMBER OF MACHINES AT WORK.
CAN BE SEEN IN OPERATION BY APPOINTMENT.

Established over 100 years.

MARTHA SIMM & SONS
— NUNS LANE MILLS, —
GATESHEAD - on - TYNE
Manufacturers of
IRONFOUNDERS' BLACKINGS,
BEST DURHAM COAL DUST,
Etc., Etc.
ENQUIRIES SOLICITED.
Telegraphic Address :
"BLACKINGS, GATESHEAD."

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The Cardonnel Tinplate Co., Ltd. } For
The Baglan Bay Tinpfate Co., Ltd. } Tinplates.
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For Blackplates, Canada Plates, etc.
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For Iron and Steel Plates, Sheets, Bars, Hoops, Rails, Angles, Tees, etc.
Collins & Son, Smethwick, Birmingham.
For Iron, Steel, Metal, and all classes of Ships' Fittings.
John S. Craig & Co., Ltd., Glasgow.
Manufacturers of Oils, Paints, Tar and White Lead, etc., etc.

We manufacture and can supply immediately
LOW GRADE
FERRO SILICON
8/10% 10/12% 12/15% and 20/25%.
THE NEWCASTLE ALLOY CO., LTD.,
Milburn House,
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Telephone : 800 CITY (7 lines).
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GIVE THE BRITISH
MANUFACTURER FIRST CHANCE.

S. J. BURRELL PRIOR, LTD.,
Equitable House,
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TIN PLATES,
BLACK PLATES,
ROUND & RECTANGULAR PLATES,
For Enamelling and Deep Stamping.
Telegrams : "PRIOR, LONDON."

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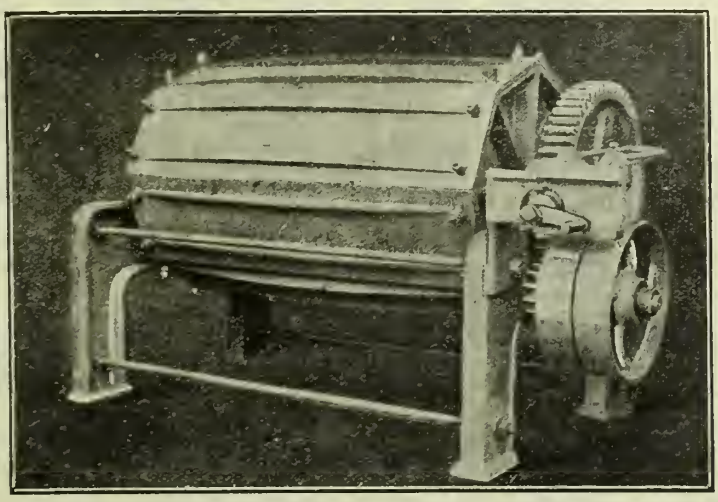

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TUMBLING BARRELS.
MOULDING MACHINES.
POWER RIDDLES.
EMERY GRINDERS.
SEND FOR FULL PARTICULARS.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	61	10	0
Three months	62	7	6
Electrolytic	69	5	0
Tough	64	15	0
Best selected	64	15	0
Sheets	96	0	0
India	84	0	0
Wire bars	69	10	0
Do. Dec.	69	10	0
Do. Jan.	69	10	0
Ingot bars	69	10	0
H.C. wire rods	74	0	0
Off. aver. cash, Oct.	62	16	5 1/22
Do. 3 mths., Oct.	63	8	11 8/11
Do. Settlement Oct.	62	15	10 10/11
Do. Electro, Oct.	71	0	0
Do. B.S., Oct.	66	11	1 1/3
Aver. spot price, copper, Oct.	62	15	4 3/4
Do. Electro, Oct.	71	5	11

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d.

BRASS.

Solid drawn tubes .. 11¾d.
Brazed tubes .. .. 13½d.
Rods, drawn .. .. 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9⅞d.
Rolled metal .. 9½d.

TIN.

	£	s.	d.
Standard cash	174	12	6
Three Months	175	12	6
English	174	12	6
Bars	176	15	0
Chinese	173	10	0
Straits	176	10	0
Australian	175	15	0
Eastern	178	5	0
Banca	175	10	0
Off. aver. cash, Oct.	170	12	4 7/11
Do. 3 mths., Oct.	171	11	4 3/11
Do. Sttlment. Oct.	170	12	0 6/11
Aver. spot, Oct.	170	11	3

SPELTER.

	£	s.	d.
Ordinary	38	10	0
Remelted	33	0	0
Hard	27	0	0
Electro 99.9	40	10	0
English	37	5	0
India	28	0	0
Prime Western	38	5	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Oct.	34	0	6 3/22
Aver., spot, Oct.	34	11	4½

LEAD.

	£	s.	d.
Soft foreign ppt	26	10	0
English	27	10	0
Off. average, Oct.	25	1	3
Average spot, Oct.	25	11	3

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	41	10	0
Do. V.M. ex. whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	40	10	0
Battery plates	42	10	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	5	0
Crude	17	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
45/50%	11	10	0
75%	19	10	0

Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/2 lb.
Ferro phosphorus, 20/23%, £24
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% .. .. 1/11 lb.
Ferro-chrome—
4/6% car. £23 10
6/8% car. .. £22 10
8/10% car .. £21 10
Ferro-chrome—
Max. 2% car .. £54 0
Max. 1% car. .. £65 0
Max. 0.70% car. .. £72 10
67/70%, carbonless 1/7 lb.
Nickel—99%, cubes or pellets .. £137 10
Cobalt metal—98/99% 11/6 lb.
Aluminium—98/99% £100
Metallic Chromium—
96/98% .. .. 5 – lb.
Ferro-manganese (net) –
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in 3d lb.
Flats under 1 in. by ⅛ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	13	6	3	17	6
Bundled steel & shearings	3	1	3	3	15	0
Mixed iron & steel	3	2	6	3	8	6
Heavy cast iron	3	10	0	3	12	6
Good machinery for foundries	3	15	0	4	5	0

Cleveland—	£	s.	d.
Heavy steel	3	8	0
Steel turnings	2	14	0
Cast-iron borings	2	12	6
Heavy forge	3	12	6
Bushelled scrap	2	16	3
Cast-iron scrap	3	15	0

Lancashire—	£	s.	d.
Cast iron scrap	3	15	0
Heavy wrought	3	2	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	22	0	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97 6
Foundry No. 3	92/6
Forge No. 4	85/-
Mottled	81/6
Hematite No. 1	93/9
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	190/-
,, ,, roll iron	200/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	80/-
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/-
,, No. 3	95/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	85/6
,, foundry No. 3	87/6
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	104/2
W.C. hematite	110/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	113 –
Glengarnock foundry	115/-
Gartsherrie foundry	115/-
Monkland foundry	113/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	17	10	0

Steel—	£	s.	d.
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	5	0
Rounds, under 3in. to ⅜in.	8	15	0
Flats, over 5in. wide and up	9	10	0
Flats 5in. to 1½in	8	15	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	11	15	0
Billets, soft	6 0 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bar	6 15 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	31.14
No. 2 foundry Valley	28.00
No. 2 foundry, Birm.	23.00
Basic	29.96
Bessemer	33.77
Malleable	30.96
Grey forge	29.77
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel boops	2.90
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9&10	2.60
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
,, furnace	26/-
Durham & North. fdy.	27/6 to 30/-
,, furnace	22/6 to 25/6
Other Districts, foundry	25/- to 30/-
furnace	21/6 to 24 6

SWEDISH IRON.

Bars, hammered basis sizes. Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	18 0 0 to 18 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	.. 57½%	Tube prices are now free.
Water	.. 5 ½%	
Steam	.. 47½%	

TINPLATES.

I.C. Cokes.	20×14, box		19/7½
,,	28×20,	,,	40 3
,,	20×10,	,,	28/4½
,,	18¾×14,	,,	20 3
I.X		,,	46/-
I.X.X.		,,	52/-
F.C.B.Y	21×13⅜	,,	36/6
C.V.B.G.	16¾×15,	,,	34 9
I.C.W.	20×14,	,,	17/10½
,,	28×20,	,,	35/6
,,	20×10,	,,	25 3
,,	18¾×14,	,,	18/4½
Terneplates.	28×20,	,,	36 3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Nov. 22	62	12	6	dec.	5/-
,, 23	62	0	0	,,	12/6
,, 24	61	12	6	,,	7 6
,, 27	61	15	0	inc.	2/6
,, 28	61	10	0	dec.	5/-

Electrolytic Copper.

Nov. 22	70	10	0	No change
,, 23	70	0	0	dec. 10/-
,, 24	69	10	0	,, 10/-
,, 27	69	5	0	,, 5/-
,, 28	69	5	0	No change

Standard Tin (cash).

Nov. 22	177	10	0	dec.	10/-
,, 23	174	10	0	,,	60/-
,, 24	174	10	0	No change	
,, 27	174	15	0	inc.	5/-
,, 28	174	12	6	dec.	2/6

Tin (English ingots)

Nov. 22	177	10	0	dec.	10/-
,, 23	174	10	0	dec.	60/-
,, 24	174	10	0	No change	
,, 27	174	15	0	inc.	5/-
,, 28	174	12	6	dec.	2/6

Zinc Sheets (English)

Nov. 22	41	10	0	No change	
,, 23	41	10	0	,,	
,, 24	41	10	0	,,	
,, 27	41	10	0	,,	
,, 28	41	10	0	,,	

Spelter (ordinary)

Nov. 22	37	5	0	dec.	10/-
,, 23	36	0	0	,,	25/-
,, 24	35	5	0	inc.	5/-
,, 27	37	0	0	,,	15/-
,, 28	38	10	0	inc.	30/-

Lead (English)

Nov. 22	27	10	0	No change	
,, 23	27	10	0	,,	
,, 24	27	10	0	,,	
,, 27	27	10	0	,,	
,, 28	27	10	0	,,	

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
STOURBRIDGE, ENGLAND.

Manufacturers of
FIRE BRICKS, BLAST FURNACE BRICKS & CUPOLA BRICKS.

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Telegrams:—
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Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEED, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

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WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LUMPER

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COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. LAING, 4, Main Road, Handsworth, Sheffield.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

WANTED.—FOUNDRY MANAGER; first-class man, able to organise and obtain maximum output per moulder of high-class Grey Iron Castings up to 3 cwt. per casting, Floor, Bench and Machine Moulding; right salary to right man.—State age, salary required, and full qualifications to Box 304, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—Traveller, high-class Castings, Cylinders, etc., on commission.—Write, ROBINSON & NICHOLLS, LIMITED, Loretta Wharf, Strand-on-the-Green, Chiswick, W.4.

WANTED.—Metallurgist for large Industrial Plant; must be conversant with the latest methods of heat treatment tempering and case hardening of steel; applicants should state qualifications, experience, past and present employers, which will be treated confidentially. — Address, "Metallurgist," WM. PORTEOUS & COMPANY, Advertising Agents, Glasgow.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

FOUNDRY FOREMAN wanted for London district; must have good knowledge of general machine castings, also thoroughly understands mixture of metals; no one unless thoroughly experienced need apply.—Reply, stating wage required, to Box 294, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

SALE BY AUCTION.

SHORT NOTICE OF SALE, WITHOUT RESERVE.

DEPTFORD, S.E. The remaining FOUNDRY and FORGING

PLANT and MACHINERY,

including 3 powerful STRIPPING PRESSES, by Massey, and John Hands, a "Brayshaw" air-blast GAS FURNACE, a "Climax" portable Smith's Hearth with rotary blower and electric motor, "Monometer," "Sturtevant," and other blowers, vice and stand, anvil and stand, swage-block and stand, Smith's tools, 79 new Morgan's "SALAMANDER" CRUCIBLES and bases, 5 PYROMETERS and fittings, power grindstone, two 7 ft. x 3 ft. ¼th plate air-blast cylinders, "Albany" pump, etc., 5 sets of Monometer Furnace Castings, range of 3 incandescent heat ovens, etc., dismantled and including upwards of 50 TONS OF HEAVY WR. AND CAST SCRAP, steel shafting, large split steel and wood pulleys, belting, about 40 TONS of NEW TOOL and DIE STEEL and BILLETS, 10 tons of Steel Press Dies, 32 box and bogie trolleys, office fittings, women's new factory overalls, ambulance stretchers, a nearly new "Criterion" 3-oven gas cooking range, steam boilers, and numerous effects, which will be SOLD by AUCTION by Messrs.

J. T. SKELDING & COMPANY,

upon the premises of Messrs. FORGINGS, LTD., THE STOWAGE, DEPTFORD, S.E., on THURSDAY, DECEMBER 14, 1922, at 12 o'clock precisely.

On view day prior to and morning of sale. Catalogues of the Auctioneers, 48, Gresham Street, Guildhall, E.C.2.

PATENT.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

ADVERTISER is prepared to sell his Special Mixture and method of making Chilled Rolls. This process has been used successfully for over 20 years.—Further particulars, apply Box 306, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

MACHINERY.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

Three Lancashire Boilers, 30 ft. x 8 ft., new in 1917, reinsure 100 lbs. working pressure. Two nearly new Steel Lancashire Boilers, 30 ft. x 9 ft., reinsureable at 100 lbs. working steam pressure, complete with steam and furnace fittings, etc., ready for immediate loading, cheap for quick sale. One Lancashire Boiler, 17 ft. x 5 ft. 6 in. diameter, reinsure 80 lbs. pressure. One Lancashire Boiler, 30 ft. x 8 ft. 6 in., suitable for 160 lbs. pressure. One Vertical Cross Tube Boiler, about 13 ft. high x 6 ft. diameter, reinsureable 90 lbs. working pressure. One Hornsby Waste Heatwater Tube Boiler, about 40 h.p., reinsure 160 lbs. pressure. "Galloway" Boiler, 24 ft. x 6 ft. 8 in. diameter, reinsure 100 lbs. pressure. A number of High-pressure Receivers, each about 18 ft. 6 in. long x 4 ft. diameter for 625 lbs. per sq. in. working gas pressure. Several Dishended Cylinders, each 6 ft. x 2 ft., tested hydraulically to 150 lbs. pressure.

Catalogue of Stock Machinery, 6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

MISCELLANEOUS.

COMPANY owning Steel and Non-Ferrous Foundry with Héroult Electric Furnace, well situated in Midlands, is desirous of increasing its capital with view to purchasing Works at present held on lease. The position of Secretary and two vacancies on Board of Directors are to be filled.—Inspection invited, and interested parties are asked to write for details to Box 300, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MISCELLANEOUS.

A GOOD CORE OIL.

Here is a product which is the result of careful research work and practical experience

CORBEERITE

(Registered Trade Mark.)

Do you know Corbeerite? If not, try a cask! You will then understand why so many successful foundries use it in preference to all other gums and oils. It is an asset to every foundry **CORBEERITE also saves Sand. You can use Old Sand with it.** **CORBEERITE** can be diluted (1 part with 30 parts of water), or can be used as a stronger solution if necessary. It is used in the same way as other oils for binding purposes. **28/6** per cwt., in 4 to 5 cwt. casks, delivered, casks free. One trial drum of this oil, containing about 130 lbs., sent to each foundry at the same price. Carriage paid. This offer is solely for trial purposes, and only one cask can be sent to each foundry.

ALSO SUPPLIED IN POWDER FORM.

CORBEERITE POWDER is used with core sand for intricate work, and is particularly useful for preventing blown castings. Half a pound to a riddle-full of core sand mixed with dried horse-manure, is a real aid to clean, satisfactory work. Used also in crushed cores, and can be used in conjunction with Corbeerite Oil as a binder, but the powder is not a binder in itself. **60/-** per cwt., in 56-lb. bags, delivered. Bags free.

Write for full particulars, or send a Trial Order, TO-DAY.

Beecroft & Partners, Ltd., Metallurgical & Foundry Experts, **ST. PETER'S CLOSE, SHEFFIELD.**

SAND MILLS

One 6-foot, by J. W. Jackman, as new, lying at Manchester, **£30 F.O.R. Bradford.**

Two 4-foot sand mills, in my London Stock, good as new, underdriven, £28 each.

One 4-foot sand mill, by Phillips, overdriven, lying at Stoke-on-Trent, £28.

Pneumatic sand sifter, equal to new, £12.

Belt-driven sand sifter, in good order, £8.

CUPOLAS

No. 1. Green Cupolette, excellent condition, £25.

30" Alldays Cupola, drop bottom, as new, £50.

48" Thwaites Cupola, latest type, £110.

Above are *Selections* from Stock. I carry every kind of foundry machinery, new and secondhand. Send me your enquiries.

ALEX HAMMOND, *Foundry Machinery Merchant,*
"BOXTED," SLOUGH.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

TELEGRAMS: "IRON BILSTON."

West Midland Refining Co.,

Bilston.

COLD BLAST IRONS

for Chilled Castings.

Chills and analysis guaranteed.

CHARCOAL

REFINED HEMATITES

for Malleable Castings.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	62	5	0
Three months	63	2	6
Electrolytic	69	7	6
Tough	65	10	0
Best selected	65	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	69	5	0
Do. Dec.	69	5	0
Do. Jan.	69	5	0
Ingot bars	69	5	0
H.C. wire rods	74	5	0
Off. aver. cash, Nov. 62	17	0	7/11
Do. 3 mths., Nov. 63	14	3	9/11
Do. Settlement Nov. 62	17	1	10/11
Do. Electro, Nov. 70	9	3	9/11
Do. B.S., Nov.	66	8	9
Aver. spot price, copper, Nov.	62	16	1 3/4
Do. Electro, Nov. 70	14	3	3/4

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11¾d
Brazed tubes 13½d
Rods, drawn 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9⅞d.
Rolled metal 9½d.

TIN.

	£	s.	d.
Standard cash	176	0	0
Three Months	177	0	0
English	176	0	0
Bars	178	0	0
Chinese	175	0	0
Straits	177	15	0
Australian	177	5	0
Eastern	177	10	0
Banca	176	15	0
Off. aver., cash Nov.	179	8	9 5/22
Do. 3 mths., Nov.	180	3	5 12/22
Do. Sttlment Nov.	179	8	7 7/11
Aver. spot, Nov.	179	7	3¼

SPELTER.

	£	s.	d.
Ordinary	40	0	0
Remelted	36	0	0
Hard	28	0	0
Electro 99.9	43	10	0
English	39	15	0
India	29	0	0
Prime Western	39	10	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Nov.	36	18	9
Aver., spot, Nov.	38	0	2¾

LEAD.

	£	s.	d.
Soft foreign ppt	26	2	6
English	27	5	0
Off. average, Nov.	25	12	21 3/22
Average spot, Nov.	26	3	5½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	41	10	0
Do. V.M. ex. whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	40	10	0
Battery plates	42	10	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	0	0
Crude	17	5	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
45/50%	11	7	6
75%	20	0	0
Ferro-vanadium— 35/40%	17/3 lb. va.		
Ferro-molybdenum— 70/75% c. free	9/6 lb. mo.		
Ferro-titanium— 23/25%, carbonless	1/2 lb.		
Ferro-phosphorus, 20/23%,	£24		
Ferro-tungsten— 80/85%, carbon free	1/5 lb.		
Tungsten metal powder— 98/99%	1/11 lb.		
Ferro-chrome— 4/6% car.	£23	0	
6/8% car.	£22	0	
8/10% car.	£21	5	
Ferro-chrome— Max. 2% car.	£54	0	
Max. 1% car.	£65	0	
Max. 0.70% car.	£73	0	
67/70%, carbonless	1/7½ lb.		
Nickel—99%, cubes or pellets	£137	10	
Cobalt metal—98/99%	12/- lb.		
Aluminium—98/99%	£100		
Metallic Chromium— 96/98%	4/6 lb.		
Ferro-manganese (net)— 76/80%, loose	£15		
76/80%, packed	£16		
76/80%, export	£14	10	
Metallic manganese— 94/96%, carbonless	2/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ½ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	15	0	4	0	0
Bundled steel & shearings	3	0	0	3	17	6
Mixed iron & steel	3	1	6	3	10	0
Heavy cast iron	3	10	0	3	15	0
Good machinery for foundries	3	15	0	4	0	0
Cleveland—						
Heavy steel	3	10	0			
Steel turnings	2	16	0			
Cast-iron borings	2	15	0			
Heavy forge	3	13	9			
Bushelled scrap	2	16	3			
Cast-iron scrap	3	13	9			
Lancashire—						
Cast iron scrap	3	15	0			
Heavy wrought	3	2	6			
Steel turnings	2	2	6			

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	22	0	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	96/6
Foundry No. 3	92/-
Forge No. 4	82/6
Mottled	81/6
Hematite No. 1	94/-
Hematite M/Nos.	93/3
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	99/6
„ No. 3	94/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	85/6
„ foundry No. 3	87/6
Lincs. forge	86/6
„ foundry No. 3	87/6
„ basic	86/6
E.C. hematite	104/5
W.C. hematite	110/-

All d/d in the district.

Lancashire (d/d eq. Man.) —	
Derby forge	—
„ fonndry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	112 6
Glengarnock foundry	114/6
Gartsherrie foundry	114 6
Monkland foundry	112,6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	1	0
Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	5	0
Rounds, under 3in. to §in.	8	15	0
Flats, over 5in. wide and up	9	10	0
Flats 5in. to 1½in.	8	15	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	11	15	0
Billets, soft	6 0 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bar	6 15 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3¼
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire ronnd—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	30.14
No. 2 foundry Valley	27.50
No. 2 foundry, Birm.	23.00
Basic	29.46
Bessemer	33.27
Malleable	30.96
Grey forge	28.77
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
„ furnace	25/-
Durham & North fdy.	27/6 to 30/-
„ furnace	22/6 to 25,6
Other Districts, foundry	25/- to 30/-
„ furnace	21/6 to 24 6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment .. £ 18 s. 0 d. 0 to 18 10 0

Nail Rods— Square, round and flats ..

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas	57½%	Tube prices are now free.
Water	52½%	
Steam	47½%	

TINPLATES.

I.C.Cokes,	20×14, box		19/9
,,	28×20,	,,	40/6
,,	20×10,	,,	28/7½
,,	18¾×14,	,,	20/6
I.X.		,,	46/-
I.X.X.		,,	52/-
F.C.B.Y.	21×13⅝	,,	36/6
C.V.B.G.	16¾×15,	,,	34 9
I.C.W.	20×14,	,,	17/10½
,,	28×20,	,,	35/9
,,	20×10,	,,	25/7½
,,	18¾×14,	,,	18 4½
Terneplates,	28×20,	,,	36 6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Nov. 29	61	12	6	inc.	2/6
,, 30	62	0	0	,,	7/6
Dec. 1	62	5	0	,,	5/-
,, 4	62	5	0	No change	
,, 5	62	5	0	,,	

Electrolytic Copper.

Nov. 29	69	5	0	No change	
,, 30	69	10	0	inc.	5/-
Dec. 1	69	15	0	,,	5/-
,, 4	69	7	6	dec.	7/6
,, 5	69	7	6	No change	

Standard Tin (cash).

Nov. 29	174	0	0	dec.	12/6
,, 30	174	0	0	No change	
Dec. 1	175	0	0	inc.	20/-
,, 4	174	5	0	dec.	15/-
,, 5	176	0	0	inc.	35/-

Tin (English ingots)

Nov. 29	174	0	0	dec.	12/6
Nov. 30	174	0	0	No change	
Dec. 1	175	5	0	inc.	25/-
,, 4	171	5	0	dec.	20/-
,, 5	176	0	0	inc.	35/-

Zinc Sheets (English).

Nov. 29	41	10	0	No change	
,, 30	41	10	0	,,	
Dec. 1	41	10	0	,,	
,, 4	41	10	0	,,	
,, 5	41	10	0	,,	

Spelter (ordinary).

Nov. 29	39	0	0	inc.	10/-
,, 30	39	5	0	,,	5/-
Dec. 1	39	10	0	,,	5/-
,, 4	39	10	0	No change	
,, 5	40	0	0	inc.	10/-

Lead (English)

Nov. 29	27	10	0	No change	
,, 30	27	10	0	,,	
Dec. 1	27	5	0	dec.	5/-
,, 4	27	5	0	No change	
,, 5	27	5	0	,,	

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London:—10, Eush Lane, Cannon St., E.C.4.

Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEED, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. Makemson, 21, Beresford Road, Stretford, Manchester

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. Laing, 4, Main Road, Handsworth, Sheffield.

A WELL-KNOWN PIG-IRON SALESMAN, with extensive international connection, opening London Offices New Year, desires representation of Cold Blast or similar Iron, Hematites, Scotch Pig-irons.—Box 310, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED, for an established steel works in the North of England, a Commercial Manager to take charge of Sales and the General Business of the Foundry. Experience with electric furnaces and large power station management an advantage. Output 25 tons per week; capable of large development. Good prospects for the right man.—Reply, with photo and full particulars of experience, references, age, and salary required, etc., to Box 308, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—Metallurgist for large Industrial Plant; must be conversant with the latest methods of heat treatment tempering and case hardening of steel; applicants should state qualifications, experience, past and present employers, which will be treated confidentially. — Address, "Metallurgist," Wm. Porteous & Company, Advertising Agents, Glasgow.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, The Sheepbridge Coal & Iron Company, Limited, Chesterfield.

FOUNDRY FOREMAN wanted for London district; must have good knowledge of general machine castings, also thoroughly understands mixture of metals; no one unless thoroughly experienced need apply.—Reply, stating wage required, to Box 294, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, The Sheepbridge Coal & Iron Company, Limited, Chesterfield.

PATENT.

ADVICE and Handbook Free.—King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

ADVERTISER is prepared to sell his Special Mixture and method of making Chilled Rolls. This process has been used successfully for over 20 years.—Further particulars, apply Box 306, Offices of the Foundry Trade Journal, Bessemer House, Adelphi, Strand, London, W.C.2.

MACHINERY.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

"BREAKIR" Improved Foundry Sand Disintegrators and Mixers (capacities from one to ten tons per hour), obtain many improvements. Write for leaflets and quotations to the makers, W. Brealey & Company, Limited, Russell Street, Sheffield, or their Agents.

CASTINGS.

Modern Foundry equipped for weights up to 10 or 12 tons. Keen prices. Best quality.

Enquiries solicited for pattern making. Good deliveries.

Wm. ASQUITH (1920), Ld.

Highroad Wells Road - - - - HALIFAX

MACHINERY.—*Contd.*

New Hydraulic Brick Press, with rotary table, for making two magnesite bricks simultaneously, by Brinck & Hubner. Set of Three-throw Hydraulic Pumps, by Hathorn Davey & Company, rams 4⅜ in. x 15 in. stroke, working pressure 1,500 lbs. Nearly new Vertical Three-throw Geared and Belt-driven Hydraulic Pump, by H. Berry & Company, 2½ in. rams, 6 in. stroke, working pressure 1,500 lbs. Horizontal Boring Machine, by The Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Horizontal Boring Machine, by J. Hetherington & Sons, Limited, 5½ in. spindle, front T-slotted bedplate 10 ft. 6 in. square. Ten nearly new 18 in. Centres All-geared Head, arranged for motor drive, S.S.S. Lathes on 34 ft. 3 in. bed, by G. & A. Harvey, Limited. 15 in. Centres Surface, Sliding and Screw-cutting Lathe, on 16 ft. straight bed, by Whitcomb-Blaisdell Company. 5 ft. Arm Double-geared Radial Drilling Machine, 3 in. balanced spindle, T-slotted box bed 3 ft. 7 in. by 3 ft. 27 in. stroke "Niles" Slotting Machine, worm- and rack-driven, table 4 ft. diam. 12 in. stroke Shaping Machine, quick return motion, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery. 6,000 Lots.
Free on application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

MISCELLANEOUS.

COMPANY owning Steel and Non-Ferrous Foundry with Héroult Electric Furnace, well situated in Midlands, is desirous of increasing its capital with view to purchasing Works at present held on lease. The position of Secretary and two vacancies on Board of Directors are to be filled.—Inspection invited, and interested parties are asked to write for details to Box 300, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

The SIR JOHN CASS TECHNICAL INSTITUTE
JEWRY STREET, ALDGATE, E.C.3.

DEPARTMENT OF METALLURGY.

Head of Department ... GEO. PATCHIN, A.R.S.M., M.I.M.M.

The following special course of instruction will be continued during the Lent Term, 1923:—

FOUNDRY PRACTICE
(Ferrous and Non-Ferrous Metals)
by Geo. Patchin, A.R.S.M., M.I.M.M., and A. F. Gibbs.

Lectures and Practical Work, Monday Evenings, from 7 to 10 p.m., commencing January 8th, 1923.

A detailed syllabus of the course may be had upon application at the Office of the Institute, or by letter to the Principal.

FURNACES.

No. 6 Thwaites, good order		£90
No. 1 Greens cupolette with motor-driven fan ...		£35
120 lb. brass furnace cokefired, tilting, by Green ...		£28
600 " " " " " Morgan		£60
240 " " " gasfired " Wright Morgan		£40
600 " " " " " " "		£60

SHANKS—NEW. in Stock.

10 cwt. Evans, £10 — 4 cwt. Sankey, £5
2 " Greens, £3 — 1 " Evans, £2 10s.
All complete with ladles, brand new.

MACHINES.

"Coventry" type head ram, NEW, by Britannia, £25
"Pickles" type turnover by Evans, 18 in. x 18 in. ... £22
EVANS flypress type for 12 x 12 boxes (2 in stock) £12
Twenty others in stock, hand and pneumatic.

Send for complete list—the only stock of used foundry machinery in the country.

ALEX. HAMMOND,
Foundry Machinery Merchant, **Boxted, SLOUGH.**

To THE EDITOR of the Foundry Trade Journal.

Please send me details of the visit to the International Foundry Trade Congress and Exhibition to be held in Paris next September.

Name.....

Address.....

.....

SHOTTS IRON COMPANY, LTD.,

1, Castle St., Edinburgh.

Telephone: 8632 Cent. Telegrams: "Shotts" Edinburgh.

Branch Office—

141, West George St., Glasgow.

Approximate Analyses of SHOTTS Foundry and Forge PIG IRON

	No 1.	No. 3.			No. 4.			
	Per cent.	Soft. Per cent.	Medium Per cent.	Hard. Per cent.	Soft. Per cent.	Hard Per cent.	Mottled. Per cent.	White. Per cent.
Iron	91.57	92.21	92.31	92.46	92.83	93.75	93.85	94.14
Graphite	3.25	3.00	2.98	2.90	2.95	2.60	2.00	0.60
Combined Carbon	0.18	0.23	0.33	0.45	0.50	0.60	1.50	2.80
Silicon	3.25	2.80	2.60	2.40	2.00	1.40	0.90	0.56
Sulphur	0.02	0.03	0.05	0.06	0.07	0.10	0.15	0.30
Phosphorus	0.80	0.80	0.80	0.80	0.72	0.70	0 70	0.70
Manganese	0.93	0.93	0.93	0.93	0.93	0.85	0.90	0.90

In addition to PIG IRON we are producers of the following :—

COAL for Steam, Gas and Household purposes.
LIMESTONE for Blast Furnaces and Foundries.
LIME for Building, agricultural purposes, etc.
SHOTTS BRICK for building purposes.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

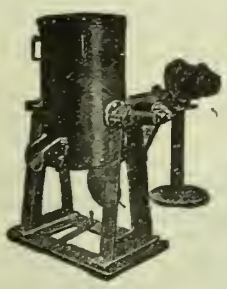
Telegrams: "LOWOOD, DEEPCAR."

GREEN'S EMERGENCY CUPOLA IS A GREAT MONEY SAVER

Sizes from 5 to 40 cwts. capacity per hour.

GREEN'S STEEL CONVERTER PLANTS ARE SECOND TO NONE.

COMPLETE FOUNDRY MELTING EQUIPMENTS
FOR DEALING WITH
CAST IRON, STEEL, AND BRASS
ARE OUR SPECIALITY.



Green's Rapid "Economic" CUPOLA is the last word in Cupola design.

Hundreds of Highly Satisfied Users will confirm this

Ask for complete Catalogue of Foundry Plant, and file for future reference.

GEORGE GREEN & CO., Foundry Engineers and Contractors, KEIGHLEY.

Telegrams: "Cupola." Telephone: 518. Codes: Western Union, Lieber's 5-letter Code, Marconi International.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	10	0
Three months	63	5	0
Electrolytic	69	0	0
Tough	65	15	0
Best selected	65	15	0
Sheets	96	0	0
India	84	0	0
Wire bars	69	12	6
Do. Jan.	69	12	6
Do. Feb.	69	12	6
Ingot bars	69	2	6
H.C. wire rods	73	15	0
Off. aver. cash, Nov.	62	17	0 6/11
Do. 3 mths., Nov.	63	14	3 9/11
Do. Settlement Nov.	62	17	1 1/11
Do. Electro, Nov.	70	9	3 9/11
Do. B.S., Nov.	66	8	9
Aver. spot price, copper, Nov.	62	16	1 3/4
Do. Electro, Nov.	70	14	3 3/4

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11¾d.
Brazed tubes 13½d
Rods, drawn 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9¼d.
Rolled metal 9½d.

TIN.

	£	s	d
Standard cash	175	10	0
Three Months	176	15	0
English	175	10	0
Bars	177	10	0
Chinese	174	5	0
Straits	177	5	0
Australian	176	15	0
Eastern	181	0	0
Banca	176	5	0
Off. aver., cash, Nov.	179	8	9 5/22
Do. 3 mths., Nov.	180	3	5 5/22
Do. Sttlment Nov.	179	8	7 7/11
Aver. spot, Nov.	179	7	3¼

SPELTER.

	£	s	d
Ordinary	Nominal		
Remelted	36	0	0
Hard	28	0	0
Electro 99.9	44	0	0
English	39	10	0
India	29	0	0
Prime Western	39	10	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Nov.	36	18	9
Aver., spot, Nov.	38	0	2¾

LEAD.

	£	s	d
Soft foreign ppt	26	2	5
English	27	5	0
Off. average, Nov.	25	12	2 3/22
Average spot, Nov.	26	3	5½

ZINC SHEETS, &c.

	£	s	d
Zinc sheets, English	42	0	0
Do. V.M. ex. whf.	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates	43	0	0

ANTIMONY.

	£	s	d
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	0	0
Crude	17	0	0

QUICKSILVER.

Quicksilver £12 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—		
45/50%	£11	7 6
75%	£20	0 0
Ferro-vanadium— 35/40%	17/- lb. va.	
Ferro-molybdenum— 70/75% c. free	9/6 lb. mo.	
Ferro-titanium— 23/25%, carbonless	1/2½ lb.	
Ferro-phosphorus, 20/23%,	£24	
Ferro-tungsten— 80/85%, carbon free	1/5 lb.	
Tungsten metal powder— 98/99%	1/11 lb.	
Ferro-chrome— 4/6% car.	£22	0
6/8% car.	£21	10
8/10% car.	£20	0
Ferro-chrome— Max. 2% car.	£54	0
Max. 1% car.	£65	0
Max. 0.70% car.	£73	0
67/70%, carbonless	1/7 lb.	
Nickel—99%, cubes or pellets	£130	0
Cobalt metal—98/99%	11/6 lb.	
Aluminium—98/99%	£100	
Metallic Chromium— 96/98%	4/6 lb.	
Ferro-manganese(net)— 76/80%, loose	£15	
76/80%, packed	£16	
76/80%, export	£14	10
Metallic manganese— 94/96%, carbonless	2/3 lb.	

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d	£	s.	d
Heavy Steel	3	16	0	4	2	6
Bundled steel & shearings	3	2	6	3	17	6
Mixed iron & steel	3	5	0	3	10	0
Heavy cast iron	3	12	6	3	17	6
Good machinery for foundries				4	0	0

Cleveland—			
Heavy steel	3	10	0
Steel turnings	2	16	0
Cast-iron borings	2	15	0
Heavy forge	3	13	9
Bushelled scrap	2	16	3
Cast-iron scrap	3	13	9

Lancashire—			
Cast iron scrap	3	15	0
Heavy wrought	3	2	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	23	0	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/6
Foundry No. 3	91/6
Forge No. 4	82/6
Mottled	81/6
Hematite No. 1	94/3
Hematite M/Nos.	93/6
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	190/-
,, ,, roll iron	200/-
,, basic	—
Northants forge	70/- to 72/6
,,foundry No. 3	77/6 ,, 80/-
,, basic	80/-
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basio	80/-
Scotland—	
Foundry No. 1	99/6
,, No. 3	94/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	85/6
,, foundry No. 3	87/6
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	104/8
W.C. hematite	110/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	109/6
Glengarnock foundry	111/6
Gartsherrie foundry	111/6
Monkland foundry	109/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	5	0
Rounds, under 3in. to ⅜in.	8	15	0
Flats, over 5in. wide and up	9	10	0
Flats 5in. to 1½in.	8	15	0

	£	s.	d
Rails, heavy	8	15	0
Fishplates	13	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	11	15	0
Billets, soft	6 10 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bar	6 17 6 to 7	13	9

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.14
No. 2 foundry Valley	27.00
No. 2 foundry, Birm.	23.00
Basic	28.46
Bessemer	32.27
Malleable	29.96
Grey forge	28.27
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	37.00
O.-h. billets	37.00
O.-h. sheet bars	37.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
,, furnace	25/-
Durham & North. fdy.	27/6 to 30/-
,, furnace	22/6 to 25/6
Other Districts, foundry	25/- to 30/-
,, furnace	21/6 to 24/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£	s.	d.
Rolled Ordinary— Assortment ..	18	0	0
Nail Rods— Square, round and flats ..	18	to 10	0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	57½%	Tube prices are now free.
Water	52½%	
Steam	47½%	

TINPLATES.

I.C. Cokes,	20×14, box		20/–
,,	28×20,	,,	40/6
,,	20×10,	,,	29/–
,,	18¾×14,	,,	20/6
I.X.		,,	46/–
I.X.X.		,,	52/–
F.C.B.Y.	21×13⅝	,,	36/9
C.V.B.G.	16¾×15,	,,	35/–
I.C.W.	20×14,	,,	17/10½
,,	28×20,	,,	36/–
,,	20×10,	,,	25/9
,,	18¾×14,	,,	18/6
Terneplates,	28×20.	,,	37/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Dec.	6	62	7	6	inc.	2/6
,,	7	62	10	0	,,	2/6
,,	8	62	10	0	No change	
,,	11	62	12	6	inc.	2/6
,,	12	62	10	0	dec.	2/6

Electrolytic Copper.

Dec.	6	69	10	0	inc.	2/6
,,	7	69	10	0	No change	
,,	8	69	10	0	,,	
,,	11	69	10	0	,,	
,,	12	69	0	0	dec.	10

Standard Tin (cash)

Dec.	6	179	5	0	inc.	65/–
,,	7	180	2	6	,,	17/6
,,	8	180	15	0	,,	12/6
,,	11	178	17	6	dec.	37/6
,,	12	175	10	0	,,	67/6

Tin (English ingots)

Dec.	6	179	5	0	inc.	65/–
,,	7	180	5	0	inc.	20/–
,,	8	181	0	0	,,	15/–
,,	11	180	0	0	dec.	20/–
,,	12	175	10	0	,,	90/–

Zinc Sheets (English).

Dec.	6	41	10	0	No change
,,	7	41	10	0	,,
,,	8	42	0	0	inc. 10/–
,,	11	42	0	0	No change
,,	12	42	0	0	,,

Spelter (ordinary)

Dec.	6	—		Nominal
,,	7	—		,,
,,	8	40	0	0 No change
,,	11	39	10	0 dec. 10/–
,,	12	—		Nominal

Lead (English)

Dec.	6	27	5	0	No change
,,	7	27	5	0	,,
,,	8	27	5	0	,,
,,	11	27	5	0	,,
,,	12	27	5	0	,,

There's something for You among these —

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. Laing, 4, Main Road, Handsworth, Sheffield.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, The Sheepbridge Coal & Iron Company, Limited, Chesterfield.

WANTED, Foreman for Aluminium Foundry. Must have good experience in this metal and be good organiser, with intimate knowledge of modern machine moulding. Only keen men need apply.—Box 312, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, The Sheepbridge Coal & Iron Company, Limited, Chesterfield.

SALE BY AUCTION.

ON VIEW MONDAY. SALE TUESDAY NEXT.
THE STOWAGE, DEPTFORD.

The remaining FOUNDRY & FORGING

PLANT AND MACHINERY

OF MESSRS. FORGINGS, LIMITED,

including 3 powerful TRIMMING PRESSES, by Massey, and John Hands, a "Brayshaw" air-blast GAS FURNACE, a "Climax" portable Smith's hearth with rotary blower and electric motor; "Monometer," "Sturtevant," and other blowers, vice, anvil, swage block and stands, 79 new Morgan's "SALAMANDER" CRUCIBLES and bases, five 0-1200 Pyrometers, two 7 ft. by 3 ft. ⅛th plate galvanised iron cylinders, one 200-gal. galv. open cistern, one 500-gal. welded wt. iron tank with steam coil, Albany pump, power grindstone, five sets of 800-lb. Lip-Axis type MONOMETER MELTING FURNACES, range of three INCANDESCENT HEAT OVENS, etc., dismantled and including upwards of 40 TONS of heavy WT. and CAST SCRAP, steel shafting, large steel and wood split pulleys, belting, upwards of 40 TONS NEW TOOL & DIE STEEL & BILLETS, 10 tons of steel press dies, two sets of "Climax" 1-ton lifting tackle, 40 box and flat top Foundry Bogies, the fittings for a 12-ft. lift, sets of women's new factory overalls, ambulance stretchers, a nearly-new "Criterion" 3-oven gas-cooking range, steam boilers, office fittings, and numerous effects, which will be SOLD BY AUCTION by Messrs.

J. T. SKELDING & CO.,

at "The Duke" P.H., 125, CREEK ROAD, DEPTFORD, S.E. (by kind permission), on TUESDAY, DECEMBER 19, 1922, at 12 o'clock, sharp. Catalogues of the Auctioneers, 48, Gresham Street, Guildhall, E.C.2.

TENDERS

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive tenders for the supply of the undermentioned Stores from the 1st of January, 1923, to the 30th of June, 1923.

1.—Laminated Springs.
2.—Helical and Volute Springs.
3.—Steel Tyres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres and Bosses).
9.— Do. (Miscellaneous).
11.—Chain and Special Iron for Chain Manufacture.
12.—Tubes and Fittings.
13.—Solid Drawn Steel Tubes.
14.—Cast Iron Socket Pipes, Lamp Posts, &c.
15.—Galvanized Sheets.
16.—Tool Steel.

Specifications and forms of tender (upon which alone tenders will be received) may be obtained on application to the Stores Superintendent at Swindon.

Tenders addressed to the undersigned and marked outside "Tender for Iron and Steel" will be received not later than 10.0 a.m. on Thursday, the 21st December, 1922.

The Directors do not bind themselves to accept the lowest or any tender.

A. E. BOLTER, Secy.

Paddington Station, London, 7th December, 1922.

MACHINERY.

New Hydraulic Brick Press, with rotary table, for making two magnesite bricks simultaneously, by Brinck & Hubner. Set of Three-throw Hydraulic Pumps, by Hathorn Davey & Company, rams 4⅜ in. x 15 in. stroke, working pressure 1,500 lbs. Nearly new Vertical Three-throw Geared and Belt-driven Hydraulic Pump, by H. Berry & Company, 2½ in. rams, 6 in. stroke, working pressure 1,500 lbs. Horizontal Boring Machine, by The Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Horizontal Boring Machine, by J. Hetherington & Sons, Limited, 5½ in. spindle, front T-slotted bedplate 10 ft. 6 in. square. Ten nearly new 18 in. Centres All-geared Head, arranged for motor drive, S.S.S. Lathes on 34 ft. 3 in. bed, by G. & A. Harvey, Limited. 15 in. Centres Surface, Sliding and Screwcutting Lathe, on 16 ft. straight bed, by Whitcomb-Blaisdell Company. 5 ft. Arm Double-geared Radial Drilling Machine, 3 in. balanced spindle, T-slotted box bed 3 ft. 7 in. by 3 ft. 27 in. stroke "Niles" Slotting Machine, worm- and rack-driven, table 4 ft. diam. 12 in. stroke Shaping Machine, quick return motion, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery. 6,000 Lots.
Free on application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

PATENT.

ADVICE and Handbook Free.—King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

ADVERTISER is prepared to sell his Special Mixture and method of making Chilled Rolls. This process has been used successfully for over 20 years.—Further particulars, apply Box 306, Offices of the Foundry Trade Journal, Bessemer House, Adelphi, Strand, London, W.C.2.

MISCELLANEOUS.

A GOOD CORE OIL.

Here is a product which is the result of careful research work and practical experience

CORBEERITE

(Registered Trade Mark.)

Do you know Corbeerite? If not, try a cask! You will then understand why so many successful foundries use it in preference to all other gums and oils. It is an asset to every foundry **CORBEERITE also saves Sand. You can use Old Sand with it.**

CORBEERITE can be diluted (1 part with 30 parts of water), or can be used as a stronger solution if necessary. It is used in the same way as other oils for binding purposes **28/6** per cwt., in 4 to 5 cwt. casks, delivered, casks free. One trial drum of this oil containing about 130 lbs., sent to each foundry at the same price. Carriage paid. This offer is solely for trial purposes, and only one cask can be sent to each foundry.

ALSO SUPPLIED IN POWDER FORM.

CORBEERITE POWDER is used with core sand for intricate work, and is particularly useful for preventing blown castings. Half a pound to a riddle-full of core sand mixed with dried horse-manure, is a real aid to clean, satisfactory work. Used also in crushed cores, and can be used in conjunction with Corbeerite Oil as a binder, but the powder is not a binder in itself. **60/-** per cwt., in 56-lb. bags, delivered. Bags free.

Write for full particulars, or send a Trial Order, TO-DAY.

Beecroft & Partners, Ltd., Metallurgical & Foundry Experts, **ST. PETER'S CLOSE, SHEFFIELD.**

FURNACES.

No. 6 Thwaites cupola, good order, 4′ 6″ dia. ...	£90
30″ Cupola, NEW, by Green, with staging bricks, blower, crane etc.	£110
No. 1 Greens cupolette with motor-driven fan ...	£35
120 lb. brass furnace cokefired, tilting, by Green ...	£28
600 ,, ,, ,, ,, ,, ,, Morgan	£60
600 lb. Wright gasfired tilting furnace, lip axis ...	£60

SHANKS—NEW, in Stock.

10 cwt. Evans, **£10** — 4 cwt. Sankey, **£5**
2 ,, Greens, **£3** — 1 ,, Evans, **£2 10s.**

All complete with ladles, brand new.

MACHINES.

"Coventry" type head ram, NEW, by Britannia, **£25**
"Pickles" type turnover by Evans, 18 in. x 18 in. ... **£22**
EVANS flypress type for 12 x 12 boxes (2 in stock) **£12**

Twenty others in stock, hand and pneumatic.

Send for complete list—the only stock of used foundry machinery in the country.

ALEX. HAMMOND,
Foundry Machinery Merchant, **Boxted, SLOUGH.**

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

THE "CLIMAX"

A HIGHLY DEVELOPED PLANT AT A COMPETITIVE PRICE, AND A SOUND INVESTMENT.

Capacities of Molten Iron from 10 cwt. per hour for the *fixed type set*, and from 5 cwt. per hour in the *hinged type set*.

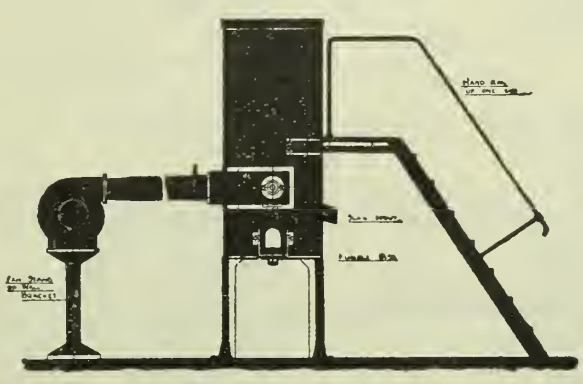
Drawings and prices given for Complete Foundry Melting Equipment, embodying our "Climax" Cupolas from 5 cwt. to 15 tons capacity of molten iron per hour.

E. ROPER & CO., Foundry Equipment Engineers,

71, North St., KEIGHLEY.

Phone: 593. Grams: "Climax."

Emergency CUPOLA Equipment,
with Fixed Type Furnace.



WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	64	0	3
Three months	64	17	6
Electrolytic	70	10	0
Tough	66	10	0
Best selected	66	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	7	6
Do. Jan.	70	7	6
Do. Feb.	70	7	6
Ingot bars	70	5	0
H.C. wire rods	74	0	0
Off. aver. cash, Nov.	62	17	0 6/11
Do. 3 mths., Nov.	63	14	3 9/11
Do. Settlement Nov.	62	17	1 10/11
Do. Electro, Nov.	70	9	3 9/11
Do. B.S., Nov.	66	8	9
Aver. spot price, copper, Nov.	62	16	1 3
Do. Electro, Nov.	70	14	3¾

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13½d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d.

BRASS.

Solid drawn tubes .. 11½d.
Brazed tubes .. .. 13½d.
Rods, drawn .. .. 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. 9½d.
Rolled metal .. 9½d.

TIN.

	£	s.	d.
Standard cash	180	5	0
Three Months	181	10	0
English	180	0	0
Bars	182	0	0
Chinese	178	0	0
Straits	182	0	0
Australian	181	10	0
Eastern	184	10	0
Banca	181	0	0
Off. aver. cash Nov.	179	8	9 1/2 2/2
Do. 3 mths., Nov.	180	3	5 1/2 2/2
Do. Sttlment Nov.	179	8	7 7/11
Aver. spot, Nov.	179	7	3¼

SPELTER.

	£	s.	d.
Ordinary	38	10	0
Remelted	35	10	0
Hard	28	0	0
Electro 99.9	44	0	0
English	38	10	0
India	29	0	0
Prime Western	38	10	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Nov.	36	18	9
Aver., spot, Nov.	38	0	2¾

LEAD.

	£	s.	d.
Soft foreign ppt	25	12	6
English	27	0	0
Off. average, Nov.	25	12	2 3/22
Average spot, Nov.	26	3	5½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	0	0
Do. V.M. ex. whf	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates	43	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	0	0
Crude	17	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 11 7 6
75% 20 0 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1½ lb.

Ferro-phosphorus, 20/23%, £24

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/11 lb.

Ferro-chrome—
4/6% car. £23 10
6/8% car. £22 10
8/10% car. .. £21 10

Ferro-chrome—
Max. 2% car. .. £54 0
Max. 1% car. .. £65 0
Max. 0.70% car. .. £73 0
67/70%, carbonless 1/7 lb.

Nickel—99%, cubes or pellets .. £130 0

Cobalt metal—98/99% 11/6 lb.

Aluminium—98/99% £95

Metallic Chromium—
96/98% .. .. 4/6 lb.

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	17	6	4	5	0
Bundled steel & shearings	3	5	0	3	17	6
Mixed iron & steel	3	10	0	3	17	6
Heavy cast iron	3	15	0	3	17	6
Good machinery for foundries	3	10	0	4	5	0

Cleveland—
Heavy steel .. 3 8 6
Steel turnings .. 2 16 0
Cast-iron borings 2 16 0
Heavy forge .. 4 0 0
Bushelled scrap .. 3 12 6
Cast-iron scrap .. 3 15 0

Lancashire—
Cast iron scrap .. 3 15 0
Heavy wrought .. 3 10 0
Steel turnings .. 2 2 6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	23	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—
Foundry No. 1 .. 95/-
Foundry No. 3 .. 91/-
Forge No. 4 .. .. 82/6
Mottled 81/6
Hematite No. 1 .. 93/9
Hematite M/Nos. .. 93/-

Midlands—
Staffs. common .. —
„ part-mine forge —
„ „ foundry —
„ Cold blast, ord. 190/-
„ „ roll iron 200/-
„ basic .. .. —

Northants forge 70/- to 72/6
„ foundry No. 3 77/6 „ 80/-
„ basic 80/-

Derbyshire forge .. 75/-
„ foundry No. 3 82/6
„ basic .. 80/-

Scotland—
Foundry No. 1 .. 99/6
„ No. 3 .. 94/6
Hematite M/Nos. .. 107/6

Sheffield (d/d district)—
Derby forge 85/6
„ foundry No. 3 87/6
Lincs. forge 86/6
„ foundry No. 3 87/6
„ basic 86/6
E.C. hematite .. 104/2
W.C. hematite 105/- to 110/-
All d/d in the district.

Lancashire (d/d eq. Man.) —
Derby forge .. .. —
„ foundry No. 3 90/-
Northants foundry No. 3 .. .. —
Cleveland foundry No. 3 .. .. —
Staffs. foundry No. 3 —
Lincs. forge .. .. —
„ foundry No. 3 —
Summerlee foundry .. 109/6
Glengarnock foundry 111/6
Gartsherrie foundry 111/6
Monkland foundry .. 109/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0

Steel—
Ship plates £9 to 9 10 0
Boiler plates .. 12 10 0
Chequer plates 10 5 0
Angles £8 12 6 to 9 0 0
Tees £9 12 6 to 10 0 0
Channels .. 8 10 0
Joists 9 0 0
Rounds & squares 3-in. to 5½in. .. 9 10 0
Rounds, under 3in. to ⅝in. .. 9 0 0
Flats, over 5in. wide and up .. 9 15 0
Flats 5in. to 1½in. 9 0 0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	13	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	11	15	0
Billets, soft	6 10 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bars	3 17 6 to 7	0	0
Tin bars	7 7 6 to 7	13	9

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	29.14
No. 2 foundry Valley	25.50
No. 2 foundry, Birm.	23.00
Basic	26.96
Bessemer	31.77
Malleable	28.96
Grey forge	26.77
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	36.50
O.-h. billets	36 50
O.-h. sheet bars	36.50
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/-
„ furnace 25/-
Durham & North. fdy. 27/6 to 30/-
„ furnace 22/6 to 25/6
Other Districts, foundry 25/- to 30/-
„ furnace 21/6 to 24/6

SWEDISH IRON.

Bars, hammered basis sizes	Basis price £22 to £23
Rolled Ordinary—Assortment	£18 0 0 to £18 10 0
Nail Rods—Square, round and flats	£18 0 0 to £18 10 0
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms—Single welded	£10 to £11
Billets—Single and double welded	£13 to £14
Pig-Iron—Grey, white or mottled	£7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	57½%	Tube prices are now free.
Water	52½%	
Steam	47½%	

TINPLATES.

I.C.Cokes,	20×14, box		20/1½
,,	28×20,	,,	41/-
,,	20×10,	,,	£9 3
,,	18¾×14,	,,	20/10½
I.X.		,,	47/-
I.X.X.		,,	53/-
F.C.B.Y.	21×13⅝	,,	38/-
C.V.B.G.	16¾×15,	,,	36/-
I.C.W.	20×14,	,,	18/4½
,,	28×20,	,,	36/9
,,	20×10,	,,	26/3
,,	18¾×14,	,,	19/1½
Terneplates,	28×20,	,,	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Dec. 13	62	5	0	dec.	5
,, 14	62	15	0	inc.	10/-
,, 15	63	10	0	,,	15/-
,, 18	64	2	6	,,	12/6
,, 19	64	0	0	dec.	2/6

Electrolytic Copper.

Dec. 13	68	10	0	dec.	10/-
,, 14	69	0	0	inc.	10/-
,, 15	69	10	0	,,	10/-
,, 18	70	0	0	,,	10/-
,, 19	70	10	0	,,	10/-

Standard Tin (cash)

Dec. 13	176	0	0	inc.	10/-
,, 14	176	15	0	,,	15/-
,, 15	176	15	0	No change	
,, 18	180	5	0	inc.	70/-
,, 19	180	0	0	dec.	5/-

Tin (English ingots)

Dec. 13	176	0	0	inc.	10/-
,, 14	176	15	0	inc.	15/-
,, 15	177	0	0	,,	5/-
,, 18	180	0	0	,,	60/-
,, 19	180	0	0	No change	

Zinc Sheets (English)

Dec. 13	42	0	0	No change
,, 14	42	0	0	,,
,, 15	42	0	0	,,
,, 18	42	0	0	,,
,, 19	42	0	0	,,

Spelter (ordinary).

Dec. 13	—			Nominal
,, 14				,,
,, 15				,,
,, 18				,,
,, 19	38	10	0	—

Lead (English)

Dec. 13	27	5	0	No change
,, 14	27	5	0	,,
,, 15	27	5	0	,,
,, 18	27	5	0	,,
,, 19	27	0	0	dec. 5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London:—10, Fush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEED, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. LAING, 4, Main Road, Handsworth, Sheffield.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

SITUATION required as Steel Moulder; active, strong and healthy; age 50 years; 22 years in last situation, 10 years as under-foreman; shop doing approx. 50 to 80 tons per week; castings to 3 tons; general engineering and locomotive; able to take charge. Member of F.M.B.S.; no other society.—Box, 314, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Strand, London, W.C.2.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

WANTED, Foreman for Aluminium Foundry. Must have good experience in this metal and be good organiser, with intimate knowledge of modern machine moulding. Only keen men need apply.—Box 312, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

PATENT.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

ADVERTISER is prepared to sell his Special Mixture and method of making Chilled Rolls. This process has been used successfully for over 20 years.—Further particulars, apply Box 306, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

MACHINERY.

"BREAKIR" Improved Foundry Sand Disintegrators and Mixers (capacities from one to ten tons per hour), obtain many improvements. Write for leaflets and quotations to the makers, W. BREALEY & COMPANY, LIMITED, Russell Street, Sheffield, or their Agents.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

COMPLETE New Portable Cutting Plant, £15 10s.; approval. Welding Plant, with six blowpipes, £22, including expert tuition at customer's works; approval. Cutting Blowpipes, unused, but soiled, £3; 1922 pattern.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

CASTINGS.

Modern Foundry equipped for weights up to 10 or 12 tons. Keen prices. Best quality.

Enquiries solicited for pattern making. Good deliveries.

Wm. ASQUITH (1920), Ld.

Highroad Wells Road - - - - HALIFAX.

MACHINERY. *Contd.*

Ladle and Carriage (Stevenson's), the ladle being 3 ft. 4 in. dia. at top, 2 ft. 8 in. dia. at bottom, 3 ft. 4 in. deep; 5 ft. gauge of carriage. Set of "Krom-type" Crushing Rolls, 30 in. dia. by 15¾ in. wide, having manganese steel shells, two nests of springs, tightening screws. Perforated Grinding Mills, over-driven, 7-ft., 9-ft., and 10-ft. sizes. 3-ft. Loam Mill, under-driven, with two cogged rollers, 18 in. dia. by 6 in. wide. Three "Peter's" Single-chain Grabs, each about ¾ cub. yd. capacity. "Priestman" Single-chain Grab, 1 cub. yd. capacity, four teeth each side. Five Swing Jibs, each comprising 8 ft. vertical upright, jib radius 8 ft., 20 in. by 9 in. "Goodwin-Barsby" Stone Breaker, fitted with "Era" manganese steel jaws.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

TENDERS

STEEL BEAMS, 550, Schedule S.A.634 (17th January).—Tenders are invited by the Commonwealth of Australia for the supply of the above, closing on date indicated. For Tender Forms and full particulars apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

MISCELLANEOUS.

To THE EDITOR of the Foundry Trade Journal.

Please send me details of the visit to the International Foundry Trade Congress and Exhibition to be held in Paris next September.

Name.....

Address.....

.....

Swift — Metallic — Stopping

THE BRITISH FOUNDRY CEMENT for filling up Blow Holes in Castings. It dries in one hour and it can be filed up from 6 to 12 hours.

SAMPLE FREE—AGENTS WANTED.

THE SILENT MACHINE CO.,
Savile Street, SHEFFIELD.

FOUNDRY REQUISITES.

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size). **Sands, Cements, Ganister.**—*Let us have your enquiries.*

THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.,
Normanby Brickworks, Normanby, Eston, Yorks.

AN ORDINARY OPPORTUNITY

250 Tons of excellent JOBBING BOXES, in useful sizes, with excellent fittings including Pipe and Column Boxes up to 28 ft. long, and ordinary flat top parts up to 14 ft. by 8 ft., offered at **£7 per Ton** on rails London—cannot be cast under double the money.

ODD BOXES SUPPLIED.

AN EXTRAORDINARY OPPORTUNITY

Jobbing Foundry FOR SALE AS A GOING CONCERN. Owner retiring; old-established business S.W. London. Capacity 50-60 tons weekly. Price to quick buyer **£2,500**, including all fixed plant and buildings.

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BOXTED, SLOUGH.

"Coal Economy is in the Air"

On the one hand

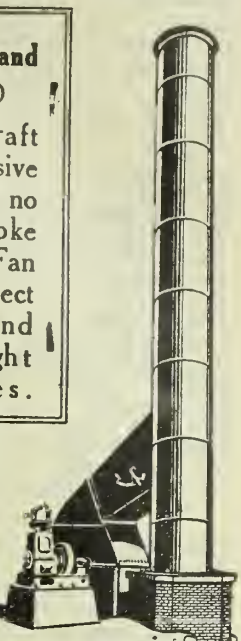
Natural Draught with costly brick chimney emitting black smoke that spells waste and the draught at the mercy of the atmospheric conditions.

Send for Catalogue No. 1009.

On the other hand

SIROCCO

Induced Draft with inexpensive steel stack and no wasteful smoke because the Fan ensures perfect combustion and correct draught at all times.



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SIROCCO WORKS,
BELFAST.
TRADE
SIROCCO
MARK

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

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DEEPCAR, nr. SHEFFIELD.

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OTLEY STREET,
KEIGHLEY.

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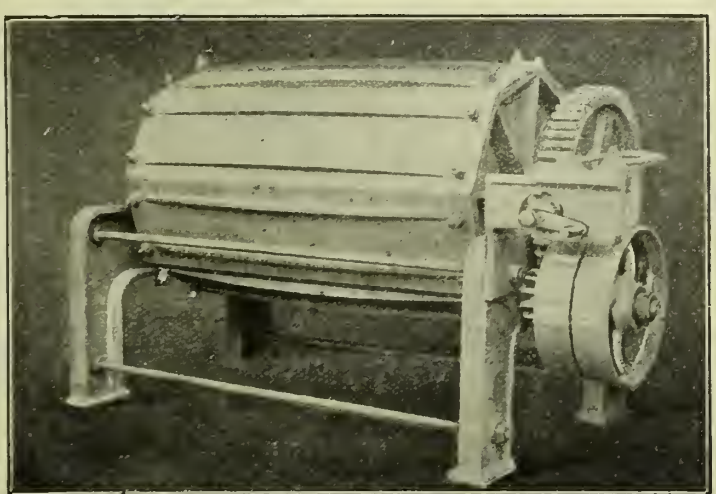

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TUMBLING BARRELS.

MOULDING MACHINES.

POWER RIDDLES.

EMERY GRINDERS.

SEND FOR FULL PARTICULARS.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	64	12	6
Three months	65	7	6
Electrolytic	71	12	6
Tough	67	10	0
Best selected	67	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	71	15	0
Do. Jan.	71	15	0
Do. Feb.	71	15	0
Ingot bars	71	15	0
H.C. wire rods	75	10	0
Off. aver. cash, Nov.	62	17	$0\frac{6}{11}$
Do. 3 mths., Nov.	63	14	$3\frac{9}{11}$
Do. Settlement Nov.	62	17	$1\frac{0}{11}$
Do. Electro, Nov.	70	9	$3\frac{9}{11}$
Do. B.S., Nov. ..	66	8	9
Aver. spot price, copper, Nov. ..	62	16	$1\frac{3}{4}$
Do. Electro, Nov.	70	14	$3\frac{3}{4}$

Solid drawn tubes .. $13\frac{1}{2}$d.
Brazed tubes .. .. $13\frac{1}{2}$d.
Wire .. .. .. $10\frac{1}{2}$d.
Yellow metal rods .. $6\frac{1}{2}$d.
Do. 4x4 Sqnares .. $8\frac{1}{2}$d.
Do. 4x3 Sheets .. $9\frac{1}{4}$d

BRASS.

Solid drawn tubes .. $11\frac{1}{2}$d.
Brazed tubes .. .. $13\frac{1}{2}$d
Rods, drawn .. .. $10\frac{1}{2}$d.
Rods, extruded or rolled $6\frac{1}{2}$d.
Sheets to 10 w.g. .. 10d.
Wire .. .. .. $9\frac{7}{8}$d.
Rolled metal .. $9\frac{1}{2}$d.

TIN.

Standard cash	182	2	6
Three Months	183	10	0
English	182	5	0
Bars	184	5	0
Chinese	179	10	0
Straits	183	15	0
Australian	183	10	0
Eastern	183	5	0
Banca	182	15	0
Off. aver., cash. Nov.	179	8	$9\frac{5}{22}$
Do. 3 mths., Nov.	180	3	$5\frac{3}{22}$
Do. Sttlment Nov.	179	8	$7\frac{7}{11}$
Aver. spot, Nov...	179	7	$3\frac{1}{4}$

SPELTER.

Ordinary	37	7	6
Remelted	35	10	0
Hard	28	0	0
Electro 99.9	42	10	0
English	38	5	0
India	29	0	0
Prime Western ..	38	5	0
Zinc dust	49	0	0
Zinc asbes	11	0	0
Off. aver., Nov. ..	36	18	9
Aver., spot, Nov. ..	38	0	$2\frac{3}{4}$

LEAD.

Soft foreign ppt ..	26	7	6
English	27	10	0
Off. average, Nov.	25	12	$2\frac{13}{22}$
Average spot, Nov.	26	3	$5\frac{1}{2}$

ZINC SHEETS, &c.

Zinc sheets, English	42	0	0
Do. V.M. ex. whf.	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates ..	43	0	0

ANTIMONY.

English regulus ..	27	0	0
Special brands ..	33	10	0
Chinese	25	0	0
Crude	17	0	0

QUICKSILVER.

Quicksilver 12 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—

45/50% ..	11	17	6
75%	20	10	0

Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/1½ lb.
Ferro-phosphorus, 20/23%, £24
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% .. .. 1/11 lb.
Ferro-chrome—
4/6% car. £23 10
6/8% car. £22 10
8/10% car. .. £21 5
Ferro-chrome—
Max. 2% car. .. £54 0
Max. 1% car. .. £65 0
Max. 0.70% car. .. £73 0
67/70%, carbonless 1/7 lb.
Nickel—99%, cubes or pellets .. £130 0
Cobalt metal—98/99% 11/6 lb.
Aluminium—98/99% £95
Metallic Chrominm—
96/98% .. .. 4/6 lb.
Ferro-manganese(net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton nnless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and sqnares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb,
Flats under 1 in. by ⅝ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..£3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	4	0	0	4	10	0
Bundled steel & shearings	3	5	0	4	0	0
Mixed iron & steel ..	3	10	0	3	17	6
Heavy cast iron ..	3	15	0	3	17	6
Good machinery for foundries	3	15	0	4	5	0

Cleveland—			
Heavy steel ..	3	8	6
Steel turnings ..	2	16	0
Cast-iron borings	2	16	0
Heavy forge ..	4	2	6
Bushelled scrap ..	3	12	6
Cast-iron scrap ..	3	16	0

Lancashire—			
Cast iron scrap ..	4	0	0
Heavy wrought ..	3	10	0
Steel turnings ..	2	7	6

London—	£	s.	d
Copper (clean) ..	57	0	0
Brass (clean) ..	32	0	0
Lead (less usual draft)	23	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings ..	64	0	0
Braziery copper ..	48	0	0
Gun metal ..	44	0	0
Hollow pewter ..	150	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1 ..	95/-
Foundry No. 3 ..	91/-
Forge No. 4	82/6
Mottled	80/-
Hematite No. 1 ..	93/9
Hematite M/Nos. ..	93/-
Midlands—	
Staffs. common ..	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge ..	75/-
„ foundry No. 3	82/6
„ basic ..	80/-
Scotland—	
Foundry No. 1 ..	99/6
„ No. 3 ..	94/6
Hematite M/Nos. ..	105/-
Sheffield (d/d district)—	
Derby forge	85/6
„ fonndry No. 3	87/6
Lincs. forge	86/6
„ foundry No. 3	90/-
„ basic	86/6
E.C. hematite ..	104/2
W.C. hematite ..	105/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ fonndry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry ..	109/6
Glengarnock foundry	111/6
Gartsherrie foundry	111/6
Monkland foundry ..	109/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins...	£11 to £12		
Nut and bolt ..	9	12	6
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates ..	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels ..	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in...	9	10	0
Rounds, under 3in. to ⅝in. ..	9	0	0
Flats, over 5in. wide and up..	9	15	0
Flats 5in. to 1½in.	9	0	0
Rails, heavy ..	8	15	0
Fishplates ..	13	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ½ in. dia	11	15	0
Billets, soft	6 10 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bars	6 17 6 to 7	0	0
Tin bars	7 7 6 to 7	13	9

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 $3\frac{1}{2}$
Wire	1 $3\frac{1}{2}$
Rods	1 $2\frac{1}{2}$
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phospbor tin (5%), £30 above price of English ingots.

Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6¾ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8¼ to 2/2¼
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8
Wire round—	
3/0 to 10. G. ..	1/8½ to 2/3½

with extras according to guage.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X fonndry, Phila.	28 75
No. 2 foundry Valley ..	25.00
No. 2 foundry, Birm. ..	22.50
Basic	26.96
Bessemer	29.27
Malleable	27.96
Grey forge	26.77
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	36.50
O.-h. billets	36 50
O.-h. sheet bars ..	36.50
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel ..	2.00
Skelp, sheared steel ..	2.00
Steel hoops	2.75
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv. ..	3.35
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry	35/-
„ furnace	25/-
Durham & North. fdy.	27/6 to 30/-
„ furnace	22/6 to 25/6
Other Districts, foundry	25/- to 30/-
„ furnace	21/6 to 24 6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	18 0 0 to 18 10 0
Rail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas	57½%	Tube prices are now free.
Water	52½%	
Steam	47½%	

TINPLATES.

I.C. Cokes,	20×14, box		20/3
„	28×20,	„	41/-
„	20×10,	„	29/6
„	18¾×14,	„	20/10½
I.X.		„	47/-
I.X.X.		„	53/-
F.C.B.Y.	21×13⅝	„	38/-
C.V.B.G.	16¾×15,	„	36/-
I.C.W.	20×14,	„	18/7½
„	28×20,	„	37/-
„	20×10,	„	26/4½
„	18¾×14,	„	19/-
Terneplates,	28×20,	„	56/9

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Dec. 20	64	5	0	inc.	5/-
„ 21	64	5	0	No change	
„ 22	64	5	0	„	
„ 26	—	—	—	—	
„ 27	64	12	6	inc.	7/6

Electrolytic Copper.

Dec. 20	71	5	0	inc.	15/-
„ 21	71	12	6	„	7/6
„ 22	71	12	6	No change	
„ 26	—	—	—	—	
„ 27	71	12	6	No change	

Standard Tin (cash).

Dec. 20	179	0	0	dec.	20/-
„ 21	179	12	6	inc.	12/6
„ 22	180	17	6	„	25/-
„ 26	—	—	—	—	
„ 27	182	2	6	inc.	25/-

Tin (English ingots)

Dec. 20	179	0	0	dec.	20/-
„ 21	179	15	0	inc.	15/-
„ 22	181	0	0	„	25/-
„ 26	—	—	—	—	
„ 27	182	5	0	inc.	25/-

Zinc Sheets (English).

Dec. 20	42	0	0	No change	
„ 21	42	0	0	„	
„ 22	42	0	0	„	
„ 26	—	—	—	—	
„ 27	42	0	0	„	

Spelter (ordinary).

Dec. 20	37	5	0	—	
„ 21	37	2	6	dec.	2/6
„ 22	37	10	0	inc.	7/6
„ 26	—	—	—	—	
„ 27	37	7	6	dec.	2/6

Lead (English)

Dec. 20	27	10	0	inc.	10/-
„ 21	27	10	0	No change	
„ 22	27	10	0	„	
„ 26	—	—	—	—	
„ 27	27	10	0	No change	

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London:—10, Eush Lane Cannon St., E.C.4.

Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

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THE

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Contents.

	PAGE
Retrospective	527
Scientific Control in Motor Cylinder Founding	528
Ferro-Manganese	530
Institution of British Foundrymen	531
Notes from the Branches	533
Comparison of Birmingham Brass Factories	534
Gravimetric Method of the Determination of Phosphorus in Pig-iron	535
Engineering at the British Empire Exhibition	535
Costs in Iron and Steel Production	536
Catalogues Received	537
Trade Talk	538
Iron and Steel Markets	539
The British Cast Iron Research Association	540
Deaths	540
Company News	540
Contracts	540

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Retrospective 1922,

The outstanding feature of the past year has been deplorable trade conditions coupled with extensive technical progress. Undoubtedly the technical progress shown can largely be attributed to the Birmingham Congress and Exhibition. This gave rise to the largest congress of foundrymen ever held in Europe. Papers were contributed from America, France and Belgium. Its international character was reinforced by the inclusion of the Presidents and other office-bearers of these associations.

Another important aspect has been the appointment of a Test Bar Committee by the Institution of British Foundrymen. They hope to publish an interim report early next year, and foreign countries are anxious to co-operate. Recognition of the international work of the Institution is shown by the number of foreign and colonial members gained this year.

The British Cast-Iron Research Association has published its first report. Obviously, one year is a totally inadequate period in which to show any striking results, and can be regarded as a seed-sowing period. Much spade work has been necessary, and with the appointment of Dr. Percy Longmuir as a full-time director, helped by suitable assistants, a good harvest should be reported by next summer. That its work and business-like methods are bearing fruit is shown by the fact that an enthusiastic Spanish foundryman is proposing to organise a similar association for his country.

An added impetus to those associated with the foundry has been given by the award of the Oliver Stubbs medal to Mr. F. J. Cook, a past-president of the Institution. No better choice could have been made, for the value of any honour becomes greater when the recipient is conscious of the calibre of the previous winners. A high standard has been set in the choice of Mr. Cook, and one worth imitating by everybody associated with British foundry practice.

Trade in the foundry industry has been poor during the last year, but better than 1921. Last month's Board of Trade returns showed that a distinct improvement had been registered, especially in the metallurgical industries.

The past year, too, saw the introduction of new types of moulding machines into Great Britain. Much of a revolutionary character has been prophesied from the results obtainable, and if they help the British founder to compete with the depreciated currency and the lower standards of living obtaining in some countries, then they should be welcomed in any foundry engaged on quantity production. How far this has been or will be fulfilled it is difficult to say, but one thing is sure, that if they are to be a success they must be approached with an open and constructive mind.

This year has seen a considerable gain in membership of the Institution, but a still greater gain in status. Its sphere is widening to take in non-ferrous foundry work, due, no doubt, to its leadership having been in the hands of Mr. H. L. Reason, the first President to be associated with this branch of the industry.

The new branch formed in the West Riding of Yorkshire has now been firmly established under the presidency of Mr. A. A. Liardet, and Mr. J. Hogg has been responsible for the equally good progress shown by the Burnley section of the Lancashire Branch. Judging from the number of unattached members residing in South Wales, it appears worth while to consider carefully the advisability of starting a branch at Cardiff. We feel sure that Mr. C. Jones, a past-president of the Institution, would lend his valuable support. As the major portion of the Institution's activities are centred in the branches, every effort should be made to extend this work by every possible means.

The closer international relations which have been established during the year have in no small measure been due to the visit of Mr. Oliver Stubbs and Mr. T. Firth to the States. Mons. Ronceray, too, has done much to co-ordinate international foundry well-being. The importance of this work cannot be exaggerated, as no country has a monopoly of brains.

Scientific Control in Motor Cylinder Founding.*

By G. H. Judd, A.M.I.Brit.F.

One often hears and reads arguments relative to the comparison of examples of founding of generations ago with those of our present-day productions, and usually to the detriment of the latter. Certainly, when we do have an opportunity of examining one of the good old examples of founding—they do not seem to have preserved any bad examples, but perhaps wasters were unknown in those days—we usually express our admiration of the product, and rightly so, but it is obvious that there were no such things as time factors in those days, and when one takes into account the speed at which castings of to-day have to be produced, the present-day productions are in advance of those of the older days. A small casting the modern motor cylinder supplies is as good an example of casting as can be found for comparison. The modern tendency to cut down the weight of this class of casting, combined with increasing intricacy of design, calls forth the best of all those concerned in the production of this article. Add to this, that the casting has to machine sound practically all over, a speck of dirt or slag, say on a valve seat, scrapping an otherwise good casting. It will be seen that this is a more difficult proposition than producing a casting for appearance only.

One is apt to associate the term "scientific control" with the part played by the works' chemist or metallurgist, but the scope of this term should be enlarged to include the core maker, moulder, examiner, and works chemist, as all are responsible in their respective spheres for the production of the finished casting, and each may exert scientific control in the part it produces.

As showing this interdependence, one may make up a perfect mould—the sort of mould, for instance, the foreman points to with pride when visitors intrude into his department—but if the wrong type of iron were used for the job a scrap casting would result, say from hardness or porosity and *vice versa*. Again, one may tap into the ladle what could be considered a perfect iron for the job—perfect, at least, as far as our present knowledge of metals goes—but if the mould should be dirty, badly rammed, or comes wrongly vented, a scrap casting would result. The foreman, by the way, is not so keen to show these sort of moulds.

Although giving due credit to the other departments concerned, it is proposed to concentrate on the part played by the works' chemist or metallurgist, as this is the part in which the author is intimately concerned, but before doing so the other sections will be touched upon.

Science in Core Making.

This includes the examination of materials, such as sand for firmness, linseed oil for paraffin and viscosity, treacle or the equivalent binder for thickness, or a rough viscosity test, as a varying consistency of this material has been proved to cause scrap in shape of collapsing cores during drying, and core gum is tested for solubility. When satisfied that the quality of materials to be used in the core mixtures is correct, the first step is to obtain a very thorough and efficient drying of the sand. A definite weight of sand—taken for ease of manipulation by box measurement—is mixed with known volumes of the various binders, the mixture being well mixed in the mill to ensure homogeneity. The cores, having been produced, are dried, not in coke stoves, which usually present difficulties of temperature control, but in gas stoves, where the required temperature can be attained within a definite period, and maintained uniformly for as long as is necessary, say for four hours at 450 deg. F. (230 deg. C.). One cannot give any really definite figure for this important operation of drying, as naturally a thin jacket core requires somewhat different heat treatment from a heavy cake-core. In modern cylinders the design is becoming increasingly intricate, which point is particularly evident during the production of many of the complicated cores which show a great tendency to distortion and buckling during the drying process, such defects being discovered when the cores undergo inspection and gauging.

The cores having been blacked—and this may appear at first sight to be a very minor operation, but it is, indeed, a very important operation, as a wrong or poor blacking mixture will nullify the effects of a good core by causing dirt and scabbing. No control has apparently been placed on what should constitute the "blacking up" mixtures, as they seem legion, but at least one can exert some control in one's own foundry. In the first place, the plumbago used in this mixing should be tested, as this material varies very much in quality. A standard having been set, it can be bought to. Good plumbago should be high in carbon and low in metallic oxides, alkalies, volatile matter and fusible ash, etc. Then a definite volume of water to known weights of plumbago, clay and treacle, should these constitute the mixture, is thoroughly mixed, and by efficient emulsifying is rendered homogeneous. As to the cores, when finished, these are finally gauged and inspected, and stored in a warm atmosphere until required.

Moulding Details.

Here, although different types of sand mixtures are used, the same remarks apply as to thorough milling and mixing of the various sands and binders. Particularly is it necessary to measure into the mill the various sands, say, as in the author's foundry, by box measurement, *i.e.*, using a suitable-size box of which the weight contents are known.

Control in Buying.

The practice of buying pig-iron to fracture is gradually dying out, and nowadays an up-to-date foundry issues a specification based on its experience and buys to this analysis and gets it—sometimes. As received, the pig-iron is stacked in truck loads, usually about 10 tons, and from 5 to 10 pieces are selected from a stack. These pieces are well scratch-brushed or sand-blasted to remove adhering loose sand and drilled on the fracture face, the drillings well mixed and submitted to a complete analysis; or, where time does not permit, to a partial analysis, usually for silicon and phosphorus. Should the iron not be reasonably near the specification it is rejected; but if within limits specified, the composition is entered on a stock card relative to that stack of pig-iron, which card contains all particulars, such as number, maker, weight, date received, etc.; and this card is then handed to foundry foreman, who then knows that the particular stack is available for use. This obviates iron being drawn upon of which no analysis or particulars are known. Coke is usually tested for ash content and sulphur, and an important point where such castings as cylinders are under cast and high temperatures of molten metal is required, the size is regulated, the largest sized coke available being preferred. Limestone and fluor spa, the usual fluxes, are occasionally tested to see if keeping up to an established standard.

Mixtures.

The points worthy of particular note in reference to mixture for the cylinders are:—

(1) Not to depend on one brand of pig-iron only, as even blast-furnaces make wasters, which wasters do not go back to the furnace as in the foundry, but are usually delivered to the customer. In other words, should one depend upon one brand of iron only, for if the maker strikes a bad patch, there arrives the possibility of being without suitable iron.

(2) Not too many irons on account of confusing the charger and loss of time in weighings.

(3) The charge must be so proportioned as to absorb the correct proportion of runners, risers and scrap castings so as to ensure that scrap does not accumulate unduly.

* A Paper presented before the Coventry Branch of the Institution of British Foundrymen.

(4) All quantities of pig-iron and scrap should be weighed and not guessed. This makes for correct analysis and saves waste, as guessing weights and putting only "shovelsful," leads to too much metal being put on.

(5) Pig-iron should be broken reasonably small, as too-large pigs tend to scaffolding in the furnace with consequent uneven melting. Cold metal may be also produced.

Melting.

Having charged up, the next important item is undoubtedly the regulation of the blast. In the cupola under the writer's notice, unfortunately, there is no apparatus for measuring the volume of air going into the furnace, but the next best thing is used—a water-pressure gauge for measuring the blast pressure. This helps at least to ensure a reasonably regular rate of melting and reasonably regular heat. The gauge is made of large dimensions, approximately 4 ft. high in the shape of a U-tube of ¾-in. bore and filled with a coloured solution to make it easily readable and noticeable to the furnace operator. When the bed has been blown hot and the melting commences, the valve on the blower is regulated to give the agreed pressure and is kept at this figure right throughout the blow, in the author's case about 6 ozs.

Casting.

This requires very little comment except to emphasise that the majority of cylinder moulds require the hottest of metal, and practice has also confirmed that casting ladles require to be scrupulously clean, especially must they be free from slag; with the result, about 4 crane ladles are used during the afternoon on account of their slagging up.

Testing.

There appears to be a great divergence of opinion as to the varying effects of the various elements in cast iron—and the works weekly journal substantiates this—and although we recognise the great effects the other elements have, rightly or wrongly, the foundry with which the author is associated depends on the silicon figure for its guide and makes provision for early knowledge on this point daily. One can readily understand that where such large numbers of cylinder moulds are put down daily through the agency of machine moulding, it is essential to supervise closely the metal. With this end in view about 4 test blocks are cast at various intervals during the blow.

The silicon and phosphorus figures taken from everyday practice, show that although mixtures may run fairly uniform, yet there is sufficient discrepancy to warrant more than one test only being taken. At end of the blow, the test-pieces are cooled, and 4 sets of drillings are taken and mixed and silicon determination started immediately. As the silicon content is taken as a most important guide for the work, to know this figure early for following days cast is imperative. As is known, the silicon content alters as the iron is melted and mixtures have been proved in our practice to lose from 0.15 per cent. to as much as 0.5 per cent.: the losses varying with the type of iron and the heat obtained during melting. By knowing the silicon content early, the scrap content which is usually a large percentage of the charge, is also known, and the mixture can be regulated accordingly and thus scientific control of the mixture from day to day is rendered possible.

Silicon Losses.

Using the same stacks of pig-iron it would hardly be supposed that the metal would so alter from day to day as to necessitate these changes, but the varying cupola losses of silicon on consecutive days shows the necessity for such slight alterations of mixture. This is shown in Table I.

Table I., showing the variations in silicon loss:—

	Sat. Sept. 19	Mon. Sept. 21.	Tues. Sept. 22.
Calc'd	2.03 silicon	2.06	2.04
Actual	1.60 ,,	1.60	1.75
Loss	0.43 ,,	0.46	0.29

Later on in the day other details such as sulphur, phosphorus, manganese and carbons are obtained, although for these details the writer usually takes a piece of broken cylinder, preferably a barrel portion, for the complete analysis.

To be able to aim at a definite analysis for the iron, it is essential to know all the changes that take place during the melting operations, so that the mixtures can be calculated accordingly.

Changes during Melting.

This, at first sight, appears quite an easy affair to ascertain. Summarised it appears to be, analyse, melt, analyse again, and it is accomplished; but when carried out under works conditions, the following special tests were carried out, which shows the difficulty of providing reliable data.

Experiment 1.—Eight cwts. of all pig-iron of a very uniform analysis were used, 10 pieces being selected off actual pigs put in. The iron was put on as last charge of the day's blow and the following analysis was obtained:—TC, 3.50; Mn, 1.00; P, 0.29; Si, 1.85; and S, 0.02 per cent.

It was tapped out of furnace, and the last 1 cwt. of metal was poured into a test-block and the partial analysis showed 0.10 per cent. S. and 0.46 per cent. P. Taking phosphorus as the best guide, it is apparent how this all pig charge, although put on last, has become contaminated with the usual cylinder-metal charges run at the same time to the extent of about 50 per cent.

Experiment 2.—The first charge of all was cylinder scrap. It was followed by 8 cwts. of pig-iron of the following compositions:—TC, 3.33; Mn, 0.56; P, 0.09; Si, 2.00; and S, 0.05 per cent.

The charges did not come down as they were put on. Ten pieces were again selected of actual pigs going into the cupola, and a test-block taken from the middle 4 cwts. of this charge and partial analysis showed that the P. has risen to 0.38 per cent., showing how this charge has become contaminated with the ordinary iron of the day and details are again useless at a charges test. One might assume, after getting this information, that it is better to put on the pig-iron charge first and then melt it before it has a chance to become mixed with other metal. The analysis of the iron used in this experiment is so definitely low in phosphorus, that it is a first-class guide as to whether or not the charge desired has been attained; but being practically a hematite, and all pig at that, it is more difficult to melt than ordinary irons, and particularly so when put on as an early charge. One has therefore to face the contingency that, being all pig-iron, it would naturally come down very cold, so that there would be a possibility of tapping hole being stopped up.

The question arises then as to how are these losses to be overcome. The only way found by the author is to put on four to six charges towards the end of the blow and to take a test block out of third or fourth charge, which certainly approximated the desired composition.

Experiment No. 4.—For this a mixture consisting of 4 cwt. of pig-iron, 3 cwt. of scrap, and 1 cwt. of steel was used. This was calculated to give the following composition:—T.C., 2.78; Mn., 1.51; P., 0.56; Si., 2.26; and S., 0.065 per cent. The actual showed it to contain T.C., 3.03; Mn., 1.07; P., 0.61; Si., 2.02; and S., 0.110 per cent. The tensile of this iron 16.82 tons per sq. in. on a 0.798 dia. test piece, whilst 2,850 lbs. was registered as the transverse test.

In this experiment the phosphorus in the resultant iron is reasonably near the calculated percentage, near enough to assume the correct charge has been tapped out. Knowing these figures, any desired analysis can thus be obtained, within reason, by taking the above losses and gains into consideration.

Inspection and Final Testing.

This is an operation in cylinder founding that, until recent years, was badly neglected. The old way was to have the castings fettled, sandblasted, inspected in a cursory manner, and despatched. This department nowadays is very important, and one from which very valuable information can be obtained from day to day both by foundry and laboratory. Further, by rigid inspection and application of special tests, it enables one to retain in the works what at first examination appears a good cylinder, but on further inspection proves to be scrap. Every water-jacketted cylinder should be water-pressure tested from 50 to 100 lbs. pressure, as this finds out those serious porous parts that the motor cylinder is liable to contain,

and extra procautions can bo taken in the core shop and foundry to obviate this trouble. Also, where largo casts of any particular cylinder is being made, one is selected, of course, usually a waster, and broken up into small pieces. Information gained from this source is vory valuable, as:

(1) The cause of tho scrap can be located, and decided whether mould, core or material is at fault.

(2) It furnishes a guide as to whether the castings are coming out regularly to dimensions, especially in barrel thickness.

(3) Provides information as to strength of the metal as to brittleness and tonghness.

(4) Exposes various fractures for visual examination as to grain size, hardness or softness, chilling, porosity and sulphur shots.

(5) Enables the chemist to take for analysis what is obviously the most important part of the cylinder, the barrel section, for complete analysis and hardness test.

Importance of Chemical Analysis.

Practically every large cylinder cast in the foundry is date-stamped with the day of the cast, the date being printed on the mould. Along with the daily silicon figure, the complete analysis is entered on a chart in graph form, which chart also contains details of the mixture, limestone used, coke used, and occasional tensile and Brinell tests. This yields valuable information, as it provides an indication as to whether any particular element is moving outside the desired limits, and when the machine-shop report is satisfactory on a run of about 500 castings, this chart can be referred to, and the details which helped lead to the good results utilised. Obviously the reverse applies with equal force.

Mixtures for Cylinders.

This must be so proportioned as to give a resultant iron of close-grain structure and to be free from porosity in order to withstand the water-pressure test. It must give a hard iron to withstand wear and friction, but not too hard to prevent ease of machining. Specially the castings must be free from chill, and in the case of many types of air-cooled cylinders the iron must be

Table II.—*Suitable composition for cylinder irons.*

—	Cylinders in general.	Water-cooled cylinders.	Air-cooled cylinders.
Total carbon ..	3.10 to 3.40	3.10	3.10
Comb. carbon..	0.40 to 0.70	0.65	0.60
Silicon	1.50 to 2.2	1.60	1.90
Manganese ..	0.60 to 1.2	1.00	0.80
Sulphur ..	0.08 to 0.12	0.09	0.10
Phosphorus ..	0.40 to 1.0	0.80	1.00

sufficiently fluid to run the fins to a good finish. To get an iron to meet all these requirements and avoid the chill is distinctly difficult. Very good results have been obtained where cylinder iron falls within the limits set out in Table II.

Mechanical Testing.

Allied to analysis is mechanical testing, which usually includes transverse test, deflection or bending, tensile strength, and hardness. It often happens that a mixture that produces good cylinders does not give the best mechanical properties, but one cannot sacrifice good castings for the sake of getting the best iron mechanically. But, at the same time, a good standard should be aimed at, and a recent test gave:—Tensile, 14.95 tons per sq. in. (.798 dia.); transverse, 2,860 on 1 in. sq. bar on 12 in. supports; deflection, 4 mm. or 0.16 in.; and hardness, 217 Brinell. The analysis to which these relate was T.C., 3.07; C.C., 0.50; Si., 1.54; Mn., 0.82; S., 0.109; and P., 0.72 per cent.

The above test is fairly typical of the regular run, and such tests as the above are carried out occasionally to ascertain that the cylinder mixtures are keeping up to standard mechanical properties. Referring to the physical tests, a very important one in reference to cylinders is the hardness test. The importance of testing for hardness at the part where the wear is likely to take place—that is, in the barrel portion—is illustrated from Table III:—

Table III.—*Illustrating the necessity for controlling hardness.*

	Bolting down boss.	Barrel section.	Diff. in Hard. Nos.
Mixture No. 1	187	166	21
„ „ 2	192	156	36
„ „ 3	217	174	43

These figures relate to a twin type of cylinder where the barrels connect without any intervening water space, and this interesting information was obtained when testing for a mixture to give a denser and harder metal in such cylinders, when the usual run of cylinder metal did not give sufficient hardness in the resultant casting.

Scrap due to Faulty Cylinder Iron.

Scrap castings can be due to unsuitable and faulty material; for example, a weak metal can cause the cylinder crown to burst under running test, and in the author's opinion the combination of high phosphorus, sulphur, and total carbon make this a poor iron for this class of cylinder. Another casting was scrapped during examination for blowholes and shots in top flange of cylinder, due to sulphur. In other castings, inability to machine and porosity in the barrel were likewise ascribed to high sulphur.

Piston castings are very liable to porosity in the bosses, and it is very noticeable that when the iron shows very high sulphur, above 0.12 per cent., this porosity may be so extended that the pistons must be scrapped after machining. Porosity in such cases is further extended by gases from finger cores.

An interesting example of a steel addition to pig-iron is one showing how the addition of 30 per cent. steel to a very soft open-grain pig so closed the grain as to bring it within the possibility of being used as a cylinder mixture. The mixture is made from 5 cwt. of pig-iron and 2¼ cwt. of steel. The analysis of the pig-iron is:—T.C., 3.30; Si., 3.74; Mn., 1.10; S., 0.05; P., 0.94. The calculated analysis gave T.C., 2.40; Si., 2.53; and P., 0.87 per cent. The actual analysis, however, was T.C., 2.80; Si., 1.90; and P., 0.71 per cent.

In conclusion, it is interesting to note that there is now a pig-iron on the market which is said to give added quality to existing cylinder irons. Although having a small quantity of this iron, the author has not yet had opportunity of trying it out, but the inclusion of vanadium, nickel and chromium in addition to the usual elements is worthy of comment. Its full analysis is:—T.C., 4.24; Si., 2.0; Mn., 0.70; S., 0.04; P., 0.08; Cr., 2.0; Ni., 1.0; Ti, 0.4. With CC., not given, it contains nine elements besides the iron (89.54 per cent.).

[A discrepancy has apparently crept in, as the text mentions vanadium and the analysis titanium. —Ed.]

Ferro-Manganese.

Of interest to British manufacturers of ferro-manganese is the appointment of a receiver for the American Manganese Manufacturing Company, one of the largest producers of the alloy in the United States. It is said to have a capacity of 150,000 tons per annum. The Company have been idle since last April.

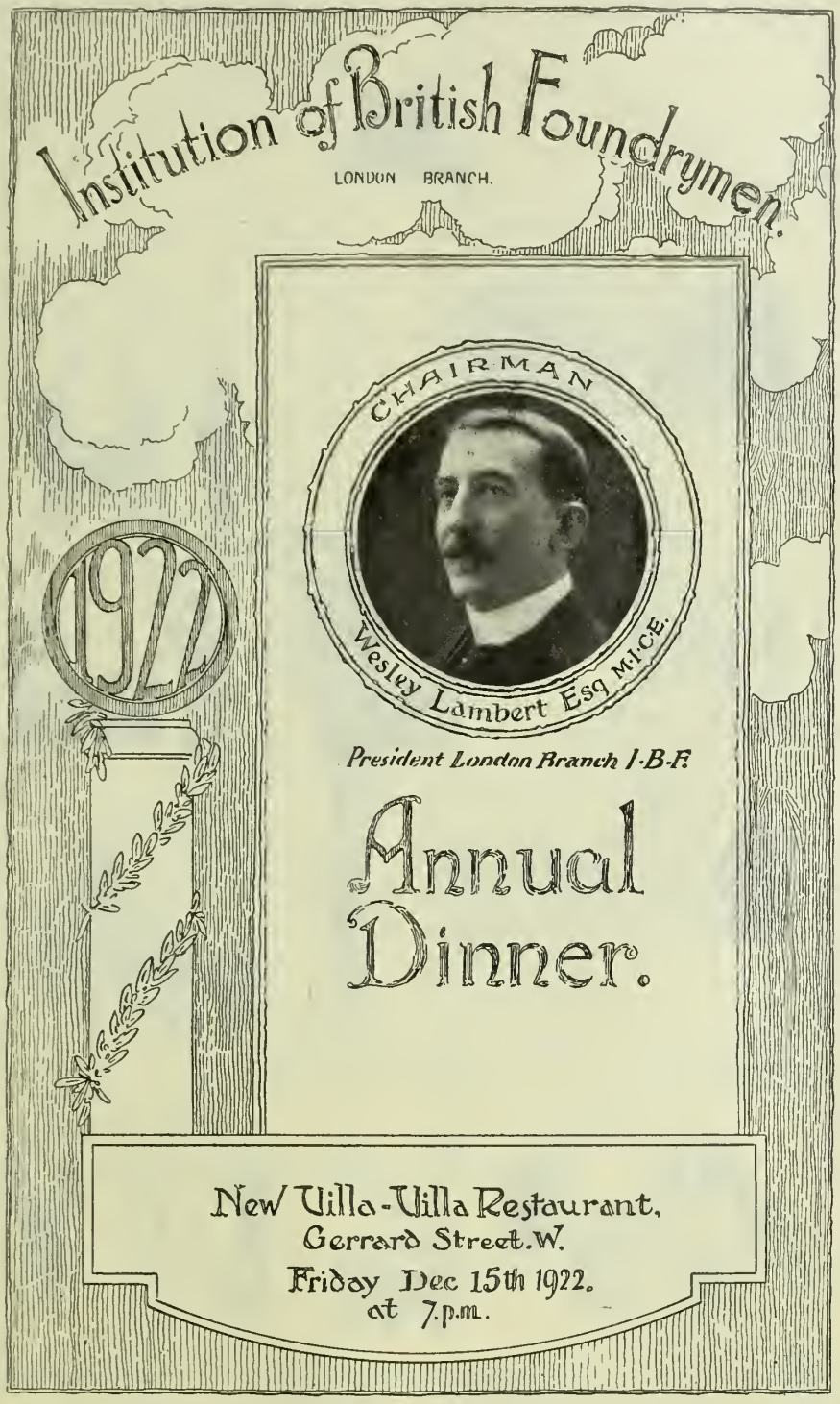
Design of Ammoniacal Liquor Stills.—Before the annual meeting of the Society of Chemical Industry at Glasgow, Mr. P. Parrish, A.I.C., in summarising his views as to the direction in which progress in the design of ammoniacal liquor stills is likely to proceed in the future, remarked that designers must concentrate their attention and energies to the evolution of the elements of a still which will be economical as regards steam consumption. Data must be arrived at as to the relative value of attenuated bubbling, as compared with time contact of the liquid and the vapours as a factor in aiding equilibrium. As regards the utilisation of the surplus heat leaving the saturator, it is evident that the present arrangement of plant as generally known must be improved in order that more satisfactory conservation of the heat available can be ensured.

Institution of British Foundrymen.

ANNUAL DINNER.

The annual dinner of the Institution of British Foundrymen took place at the New Villa-Villa Restaurant, London, on Friday, December 15, Mr. Wesley Lambert, M.I.C.E., President of the London Branch, occupying the chair.

There was a large assembly of members and visitors from all parts of the country. Amongst those present being the President of the Institution (Mr. H. L. Reason), the President-Elect and Past-President (Mr. Oliver Stubbs), Dr. Percy Longmuir, and Mr. J. Ellis (Past-President), Mr. Roxborough, of the British Thomson-Houston Company, Mr. Adamson, Secretary of the Institution of Marine Engineers, Col. W. F. Cheesewright, D.S.O., Dr. D. Hanson, Mr. G. W. Hobbs, and Mr. W. G. Hollinworth (General Secretary of the Institution).



MR. G. W. HOBBS, who proposed the toast of "The Institution of British Foundrymen," in the absence of Mr. H. B. Weeks (Chairman B.C.I.R.A.), said he thought that no one would doubt his sincerity when he said he was confident that the present and past prosperity of the British Empire was due in a very large measure to the work of such institutions as the Institution of British Foundrymen. He was sure the members must feel great pleasure in the fact that the Institution, which was formed in 1904, and held a meeting at that time at which six members were present, could now claim a membership of 1,700. Some of the gentlemen who started the Institution in 1904 were present this evening, Mr. Ellis and Dr. Longmuir being two of them, and he (Mr. Hobbs) felt particular gratification at being able to meet so many people at the gathering. He concluded by wishing prosperity to the Institution.

MR. H. L. REASON, responding to the toast, said he felt it a great pleasure to be asked to respond to the toast of "The Institution of British Foundrymen." He thought it was within his prerogative to extend to the President and Members of the London Branch the Institution's

best wishes. The London Branch had had a long and interesting career. No one thought of the London Branch without associating with it Mr. Ellis and Mr. Bartlett. But for the enthusiasm of these gentlemen and a few others they might not now be spending this pleasant evening. He might also say that as an Institution the other members envied the London Branch its Secretary (Mr. Faulkner). To have a secretary with the qualification of being Editor of the Foundry Trade Journal, put the London Branch in a unique position. After complimenting the artist on the design of the menu, he said he felt that that was a great feature of their Institution, the largely due to their immediate Past-President (Mr. O. Stubbs). He was in the unique position of being President of the National Iron Founders' Association, and he came into close contact with the employers, and lost no opportunity of putting the work of the Institution before them. It would be remembered that they made the splendid gift of the "Oliver Stubbs Medal," to be competed for annually. Another gratification they received from subscribing firms joining the Institution was that they began to sympathise with the work it was doing. A Congress and Exhibition were to be held in France next year, and at the last meeting of the Council of the Institution it was unanimously

If a brighter London - Why not a Brighter Foundry?
"Nasty Looking Boss on this Casting."
The Iron Foundry — "If Winter Comes"
The Foreman puts on a night shift
All moulds should be examined for defects
Works Metallurgist — Syphon Bricks are excellent, but why not whiskey boshes
Music would be given during meal times
Under "Brighter Foundry" conditions —
Good cheap and wholesome
The new spirit of the Foundry — A trifle cockey
Wait till I meet Pip — I'll make him squeak
Pity the blighter was'nt vaccinated

willingness of members at all times to help each other in case of difficulty, and it did not matter in what part of the British Isles they lived, or for what Branch of the Institution they worked, the object of every member was to widen its influence. The past Councils had always worked with that object in view. If they had not done so there would not have been 1,700 members to-day. Since January last they had 19 new subscribing firms, 107 members, 115 associate members, and 29 associates, a total of 270 elected since January last. That went to show they were a very live Institution. It was a gratifying fact that the list of subscribing firms was growing. This was decided that the whole of the Council be elected official representatives of the Institution at the Congress. There had been a little misunderstanding as to the extent to which the Institution would co-operate. He believed the Americans were sending over 50 foundrymen to represent their Association at the function, and they were most anxious to have the Institution of British Foundrymen with them. The Council looked forward to having 150 or more to represent the Institution. By that time the chain of office would have been passed back to Mr. Stubbs.

The Chairman, inviting Mr. Oliver Stubbs to propose the toast of the "London Branch," said

he had no hesitation in saying there had never been a more popular President than Mr. Stubbs. They had heard what Mr. Reason had said about Mr. Stubbs' work towards securing the well-being of the Institution, and they all knew that what Mr. Reason said was true. Mr. Stubbs had done this good work in a most unostentatious manner. When he (Mr. Lambert) was in America a few days ago he met with evidence of the great reception Mr. Stubbs had received there.

Mr. Oliver Stubbs, proposing the toast said he (Mr. Stubbs) would probably get into trouble for saying that he thought his toast, "The London Branch and its President," was the most important. If there was a Branch they had to be proud of it was the London one. Two or three years ago they were getting into low water, and then they pulled themselves together, largely, he thought, owing to the efforts of Mr. Faulkner. He did not think too much credit could be given to the work Mr. Faulkner had done, on top of the work he was doing during the day. The members were very pleased to see Col. Cheesewright there, and to find that the rumour that he was not at all well had been untrue. Also, it was entirely to the credit of the London members that they had travelled such great distances to attend the meetings in London. He did not think there was a Branch which was so spread about, and he knew it cost some men from 5s. to 7s. to attend a meeting. At last year's dinner they were looking forward to this year as the great year of hope. Unfortunately it had not been, but although he was an optimist, he felt that there was every sign now of revival in trade, and he hoped there was no symptom of any further reduction in wages. Some people were not ordering all they could order, because they were waiting for wages to come down. He said: "Don't bring wages down, but do a little more work." If they did that they were more likely to get their wages increased. Wages were sufficiently low in all conscience. He was sure that the London Branch would be very prosperous in view of those who were at the head of it. There was no man more qualified than Mr. Lambert to act as President. His expert opinion was valued very much, and he (Mr. Stubbs) hoped he would long be spared health and strength to continue his energies in the cause of the Institution, and he hoped the time was not far distant when Mr. Lambert would become President of the Institution.

The Chairman, in responding to the toast, gave an account of the work of the London Branch during the past years, including the reading of the important Papers and the holding of the valuable discussions, and he also expressed the thanks of the Institution to the proprietors of the important works to which visits had been made during the year, and to the gentlemen who had given their valuable time conducting the members round those works. He thanked Mr. Stubbs for his kind words in proposing the toast, and the company present for the enthusiastic manner in which they had received it.

Col. Cheesewright, Vice-President of the London Branch, also responded with a typical after-dinner speech, in which the proposer and responder came in for a good deal of humorous "leg-pulling."

Mr. V. C. Faulkner, Secretary of the London Branch, gave the toast of "The British Cast-Iron Research Association," coupled with the name of Dr. Percy Longmuir. He said that apart from being Cast-Iron Research Association, it was their baby, as its two vice-chairmen were two of our Past-Presidents (Mr. Stubbs and Mr. Cook), and on its Research Committee there were ten members of the Institution and five other people. One could see immediately the close association between the two societies. A very important aspect of the British Cast-Iron Research Association was the technical bureau. It was better to be *au fait* with good past knowledge than to be dabbling in indifferent or unproved present knowledge. Dr. Percy Longmuir was in every way qualified to be Director of the Research Association, but in one respect he was sorry he had been appointed. Hitherto, foundrymen could go to him for help in their difficulties, but now it would be a breach of confidence, unless they became members of the B.C.I.R.A.

Dr. Percy Longmuir, in response, said he wished to acknowledge his indebtedness to the officials of the British Cast-Iron Research Association. No man could have had a greater welcome nor greater help than he had had. On appointment he was given a great docket of papers from which he knew everything that had been done. He thanked the late acting-director, Mr. Fletcher, for his great help, and also the various committees. The founders in Great Britain and Ireland had also generously offered help. He felt that the coming months would show possibilities of good work by co-operation—not by the work of the individual. Machinery had already been put into force, and would be operating early in the New Year to carry out investigations to provide material, they hoped, for a series of physical constants that would prove of value to every foundry in the land. With regard to research, unless this country woke up, and the various industries supported the scientific side of their industry, they would suffer. Over 20 years ago the Krupp works in Essen had, in addition to their routine chemists, a research staff of over 60. That meant progress. The only mistake Germany made was in going to war. But this support did not mean the solving of all the problems that were current in every foundry. Co-operation was the only solution. The Research Association specialised on the grey and white cast iron, semi-steel and malleable iron, and no man could solve all those problems. He could guarantee that when reports were issued to members, scientific terms would be reduced to practical terms, and all reports would be from the foundry floor, supplemented by the best scientific aid that could be given. They had, during the last week, carried through a scheme that would give them access to the best scientific authorities in this country and also the best practice.

The Chairman, proposing the health of "The Visitors," mentioned, amongst others, Mr. Adamson, Secretary of the Institute of Marine Engineers, to whom he said they owed a great debt of gratitude for enabling them to secure such a splendid home for the London Branch. He also referred to the great service Mr. Hollinsworth, the General Secretary, had rendered to the Institution. He concluded by thanking the artistes who had contributed to the entertainment that evening, and the designer of the menu, Mr. Weatherstone. They were much indebted to him, through the good offices of Col. Cheesewright.

Dr. D. Hanson, replying on behalf of the Visitors, said the invitation to the gathering was accepted as being in the spirit of the co-operation that ought to exist between different scientific and technical societies. He came there as the Chairman of the local Branch of the Institute of Metals. One thing that pleased him very much was that as soon as it was known such a society had been formed they received a cordial invitation to hold a joint meeting with the Institution of British Foundrymen. His society also owed much to Mr. Adamson, who had also found them an extremely nice home.

The Chairman, in conclusion, thanked Col. Cheesewright and Mr. Faulkner for all they had done to make the entertainment a success.

NOTES FROM THE BRANCHES.

Lancashire Branch.

Mr. Stubbs, past-President of the Institution, recently gave an informal chat to the Branch on the subject of his American experiences. A lecture on similar lines was given before the West Riding of Yorkshire Branch, and has already appeared in our columns.

Forges et Laminoirs de l'Alliance.—This Belgian concern is increasing its capital by the issue of 20,000 new shares without indicated value at 450 fcs. each. The nominal value of the present capital is only 3,000,000 fcs., and is divided into 30,000 shares. The new shares are to rank equally with the old shares.

Comparison of Birmingham Brass Factories.

Variety of Casting Methods.

In a Paper presented before the Birmingham Local Section of the Institute of Metals by Mr. R. J. Redding, Wh.Sc., A.M.I.C.E., on December 5, entitled "Some Notes on Casting 70:30 Brass," the author gave details of some visits he made to Birmingham factories in connection with the establishment of a large concern at Southampton to provide cartridge brass during the war.

The author stated that in visiting a large number of Birmingham foundries producing brass strip of the same dimensions a point to be noticed was the great diversity of methods and equipment. In Birmingham brass had been made for generations, yet when visiting a large number of their works cases were found in which everything that could be done wrongly was being done, whereas neighbouring works were totally different. Apparently, there were no accepted or well-defined lines, and manufacturers advanced their experience of many years as an argument for the continuance of wrong methods. There had to be considerable improvement before brass could be obtained suitable for cartridge making, and, undoubtedly, the war considerably raised the standards of manufacture. It was obviously desirable to seek improvement in the direction of attaining a common general standard method. The great diversity in the size of moulds was especially noticeable, though this was partly accounted for by the rolling mill equipment available for subsequent treatment. But, as a rule, every firm was entirely satisfied, not only that the method employed was the best, but the only one possible for the production of good 70:30 brass. Further inquiry elicited the conclusion that a good surface was the only item considered, solidity of the interior either being ignored or treated as secondary.

Composition of Moulds.

In regard to moulds, too much attention could not be given to ensure good moulds of the best materials. As a rule they were made of grey cast iron, fairly open in texture. A hard iron with a fine smooth surface would seem more suitable, but in practice the life of such moulds is usually very short owing to cracking. One mould which gave a fairly long life had the following analysis:—Graphitic carbon, 3.57; combined carbon, 0.10; silicon, 2.10; manganese, 0.51; sulphur, 0.06; and phosphorus, 0.23 per cent., and it was cast from a cupola-mixture consisting of 4 cwt. of No. 1 hematite iron, 5 cwts. 3 qrs. 8 lbs. of machinery scrap, and 40 lbs. of 12 per cent. ferro-silicon. To ensure the essential good surface many firms planed the moulds before use, but there were very divided and emphatic opinions on that, and, personally, he would prefer to leave on the cast-skin. If this was clean and free from casting defects it would generally wear better than a planed surface. By casting the mould face downwards with sufficient inclination to carry up any slag or extraneous matter, and other conditions being satisfactory, a good mould should be obtainable. It was common, though not universal, to anneal moulds before use, and on this practice varied a good deal. In all cases, it was a safe practice, involving little trouble where annealing furnaces were available.

Design of Mould.

In designing the mould the metal should be equalised so that the cast ingot should have equal cooling both back and front, and the shape should be so arranged as to secure equal resistance of both sides to distortion. The sudden heating on one face only produced distortion and led to surface cracking.

Recalling his experience at Government factories, the author said that at Woolwich and Southampton screw rings for mould-clamping were used, but did not seem to be favoured in Birmingham, where wedges were employed, often driven home with great force. The ideal mould would be one without a joint at all, or with no joint at the side, and only a bottom joint as used for steelworks practice for medium and large slab ingots. Unfortunately, this was out of the question at present, in view of the size of ingots called for to meet the rolling mill conditions. They would either be too narrow or too long to admit of cleaning and dressing the moulds. With a mill of the necessary size and power it should be possible to increase largely the sizes of ingots, especially those intended for the rolling of sheets. This would give the advantage of improved surface with an important saving in labour. The nearest approach to the jointless-mould in present practice was the box pattern, with a joint at two corners of the ingot, instead of at the middle of the ingot sides. It was quite an advantage to have a free vent to the outside for any gases evolved from dressing-oil. To localise any tendency to piping and to avoid contraction-cavities across the width of the ingot, the moulds were sometimes given a slight camber, though the practice was not so general as in nickel silver ingots.

Dozzles.

With regard to hot tops, in use for many years in steelmaking and sometimes advocated for brass casting as a remedy for piping and hollow ingots, it must be remembered that the hot top could only influence the solidity of the ingot, and was not a remedy for blow-holes or surface defects. Enlarged tops, arranged by tapering out one-half of the mould, were found to be of great advantage when using tilting furnaces and pouring on to the back of the mould. With regard to the splitting of the molten stream in pouring into the mould, if the two streams became unequal, there was a danger of dirt, dross or pieces of charcoal being carried to one side, gas bubbles locating there. Obviously, the preliminary skimming in such cases must be very thorough.

Tall Moulds.

While abnormally tall moulds for brass casting have frequently been condemned, they found in steel practice, on the contrary, the adoption of schemes for putting ingot moulds on top of one another up to three high. Obvious drawbacks were the excessive fall of metal involving splashing and the liability to bind or hang in the mould. The fluid pressure resulting from the extra height would tend to increase solidity. The extensive use of this method in connection with wire drawing seemed to show that the defects encountered were not so serious as some people complained.

Mould Dressings.

Particulars were given of numerous materials used for mould dressing, and there was a wide field for research, particularly as to the properties of a porous or granular surface like open grain iron for moulds, and its effect on the surface of the alloys cast against it. The increase in melting and casting temperatures in some cases made the use of oil either difficult or impossible, and this explained why it was more difficult to obtain good surfaces on cupro-nickel than on brass, and still more so on nickel and low carbon steel. A much more careful storage and care of surfaces of ingot moulds would be to the advantage of castings produced after a rest interval. He had found great advantage in keeping moulds in the corner of a core oven.

In no case did he observe that mineral oils were used, which he considered strange in view of the wide range of properties such oils possessed.

At Southampton, where they used very large quantities of oil, they changed successively from lard oil to seal and whale oil, through the exhaustion of supplies, without observing any difference in the quality of the surfaces. Some of the finest surfaces were obtained with a dressing of melted resin, although some of the ingots were liable to black blow-holes. With excessive oil or resin dressing, a large flame and dense volumes of black, sooty smoke accompanied the pouring, adding to the men's discomforts. Yet many casters considered those volcanic effects quite necessary.

Water cooling was not considered desirable either from the point of view of the ingot surface or the mould surface, and should be avoided if possible.

Casting Temperatures.

With regard to the temperature of pouring, the author quotes with approval recommendations by experts of a range of casting temperatures for pure 70:30 brass between 1,150 and 1,220 deg. C. That recommendation was based on many years' experience at Woolwich, and they followed those temperatures as far as possible at Southampton. On his visit to Birmingham he found a very wide range of temperatures, obviously both too high and too low. There was, he thought, a great tendency to cast at low temperatures through consideration of surface, the keeping down of fuel costs, and securing "quicker" melting. The speaker strongly advocated the evolution of useful workshop tests where no scientific staff was available.

Pouring Angles and Ladle Pouring.

The angle at which the metal was poured into the moulds was worthy of consideration. Practice varied very greatly, but the ideal angle would be that which allowed the stream to fall well towards the bottom before striking. In other words, the mould should coincide as nearly as possible with the stream-line of the metal being poured. Insufficient attention had been given to the temperature of moulds, although it was fully recognised that very hot or very cold moulds gave bad surfaces. They should try to find out what was the ideal temperature for each alloy. At Southampton they had found it a good practice to leave the last batch of ingots in the moulds for the next shift, which proved sufficient to keep them warm during the interval. There was no doubt that the practice of ladle pouring with a bottom nozzle closed with a fireclay stopper, which was quite the usual practice of steelworks, would be useful in evolving non-metallic inclusions. In using a ladle a funnel would probably be necessary to guide the metal into the narrow opening of the strip mould. The common practice of bottom pouring in steel works had been advocated as applicable to non-ferrous ingots, but he (Mr. Redding) did not favour the system.

In conclusion, the author pointed out the necessity for research work on such matters as (1) properties of cast iron as a mould material with a view to improvement or the discovery of a substitute; (2) the ideal material for mould dressing; (3) robust methods for temperature measuring; (4) the part played by atmospheric moisture and surface oxidation of moulds in surface defects; (5) advantages or otherwise of fluxes; (6) the relations of height, width and depth of moulds to solidity and surface; (7) possible increases in the size of brass trade equipments on the lines of ferrous industry.

Gravimetric Method of the Determination of Phosphorus in Pig-Iron.*

Weighing as Ammonium Phosphomolybdate.

For this determination from 1 to 5 grammes of the sample are employed according to the phosphorus content. The weights recommended as most convenient are as follows: 5 grammes in all cases where the probable phosphorus content is less than 0.10 per cent., 2.5 grammes where it is between 0.10 and 0.20 per cent., and 1 gramme where it is above 0.20 per cent.

The proper amount of the sample is weighed and transferred to a glazed porcelain dish, which is provided with a cover glass, and 25 to 60 c.c. of HNO_3 (sp. gr. 1.13) are cautiously added. Gentle heat is applied until the sample is decomposed, when the solution is evaporated rapidly to dryness. The cover glass is removed and the dish and contents are heated with the full flame of an Argand or Bunsen burner until the acid is completely expelled. After cooling, 30 to 40 c.c. of concentrated HCl are added and gentle heat is applied until the soluble portion is dissolved. The dish is placed upon a suitable asbestos ring in order to prevent the formation of a crust of separated salts on the sides of the dish, and the solution is evaporated to the first appearance of a film upon its surface. The dish is then removed from the heat, 10 c.c. of concentrated HNO_3 are added, and heat is again applied for one minute. Approximately 40 c.c. of cold water are added, when the solution is stirred and filtered through an 11 cm. filter paper into a 500 c.c. flask. The filter is washed with cold HNO_3 (1:50) until free from iron solution, which insures also the complete removal of the soluble phosphate.

In the case of very exact work, the residue of silica and graphitic carbon is examined for the presence of phosphorus as follows: The residue and filter paper are ignited in a platinum crucible and the silica is volatilised with hydrofluoric acid in the presence of 2 or 3 drops of sulphuric acid. The resultant residue is mixed with a small amount of sodium carbonate, and the mixture is fused. The melt is disintegrated in hot water, the insoluble material is separated on a filter paper, and the filtrate, which contains the phosphate, is added to the main solution.

To the filtrate or filtrates are added 25 c.c. of concentrated AmOH. The flask is shaken until the precipitate coagulates, when 25 c.c. of concentrated HNO_3, which should be sufficient to dissolve the precipitate and allow an excess of 7 to 10 c.c., are added. The comparatively large amounts of ammonia and nitric acid are prescribed in the case of 5-gramme samples and are essential in that they insure a sufficient proportion of ammonium nitrate in the solution. When smaller quantities of the sample are used, the amount of ammonia may be decreased, but there should always be an excess of nitric acid as indicated.

The solution is heated to 80 deg. C., 50 to 75 c.c. of the molybdate solution are added, and the flask is shaken for five minutes. The yellow precipitate is allowed to settle, when it is collected upon a 9 cm. filter paper which has been previously dried for one hour at a temperature of 115 deg. C. and weighed between ground-edge watch glasses. The precipitate and paper are washed with HNO_3 (1:50), dried in the same manner as the paper and weighed.

The increase in weight, multiplied by 1.65 and divided by the initial weight of the sample taken, is equivalent to per cent. phosphorus.

Weighing as Magnesium Pyrophosphate.

The yellow precipitate of ammonium phosphomolybdate as obtained above, while still moist, is dissolved from the filter in a hot ammonium citrate solution, the filter is thoroughly washed with hot water, and the solution is retained in a 100-c.c. beaker. Five to 10 c.c. of magnesia mixture are added to the cold solution, which is then stirred for five minutes. After standing for three hours, the precipitate of magnesium ammonium phosphate is collected upon a 9-cm. filter and washed with AmOH (1:4) until free from soluble salts. The precipitate and paper are transferred to a porcelain crucible and ignited at a low temperature for 15 minutes and finally at a high temperature for 10 minutes. The weight of magnesium pyrophosphate is multiplied by 27.87 and divided by the weight of the sample taken to find the percentage of phosphorus.

Solutions required.

Ammonium Citrate Solution.

Citric acid	50 grammes
Concentrated ammonia ...	350 c.c.
Water	650 c.c.

Magnesia Mixture.

Magnesium sulphate ...	84 grammes
Ammonium chloride ...	250 grammes
Water	665 c.c.
Concentrated ammonia ...	335 c.c.

*A method used and published by the United States Steel Corporation.

Engineering at the British Empire Exhibition.

Mr. F. C. Fairholme and Mr. W. B. Richardson, both members of the Institution of British Foundrymen, have been asked to serve on the special committee for the Engineering Section of the British Empire Exhibition. All engineering and electrical trade exhibits are being organised by the British Engineers' Association and the British Electrical and Allied Manufacturers' Association.

Costs in Iron and Steel Production.

In his Presidential address before the West of Scotland Iron and Steel Institute at the first meeting of the new session (a report of which appears in the "Journal" of the Institute, Vol. XXX., Part 1, just issued), Mr. E. H. Lewis, M.A., dealt with the question of costs in iron and steel production, and with the methods by which they had been, and might be still further, reduced. Remarking that the best technical methods of manufacture were useless unless they lead to a cost of production which was less than the price the consumer was prepared to pay, he went on to say that costs could be roughly divided into the following classes:—(1) Raw materials, such as ores, scrap, pig-iron, fuel, etc.; (2) other materials, such as bricks, spare parts, stores, etc.; (3) transport; (4) standing charges, including taxation, both Imperial and local; (5) wages. The costs of raw materials were not under the control of the works technical staff, but the figures in Table I., showing how some of the principal raw materials had come down in price, might be of interest:—

Table I.—*Comparison of Cost of Raw Materials.*

	July, 1914.	"Peak."	October, 1922.
Ore	100	355	119
Limestone	100	277	200
Coal	100	323	200
Coke	100	359	154
Hematite pig-iron ..	100	460	161
Scrap	100	500	143
Ferro-manganese ..	100	462	182
Silica bricks	100	289	160

Transport rates have been reduced in recent months, but only to a small extent, and they are still far too high to permit of a general resumption of trade. At the highest point the extra cost of transport, compared with 1914, showed an increase of between 20s. and 30s. per ton of plates.

Standing charges generally do not come within our consideration, but, owing to recent decisions with regard to local taxation, it has become more and more necessary for the technical staff to take cognisance of this question. Without going into details, an example may be given which seems to show that, in the words of Mr. Bumble, "the law is a ass." It has been decided that, where electric power is purchased, a rotary converter is wholly a heritable subject, whereas in the case of a motor-generator the motor is heritable and the dynamo is not. From prices recently received it appears that for a supply of 250 kw. of direct current a rotary converter would cost approximately £200 less than a motor-generator. But with owner's and occupier's rates together at 15s. in the pound the capital sum representing the annual rates to be paid is £510 more in the case of the rotary converter. Of course, this is only one point which must be taken into consideration in deciding on one form of conversion or the other.

There are two points with regard to wages about which much confusion exists in the public mind—the question of nominal wages as against real wages, and the question of wages rates as against wages costs. In order to try and shed some light in an elementary way on these questions some figures have been prepared. Table II. shows the varying wages costs of a ton of acid-steel plates, made from hematite pig-iron produced in coal-fired blast furnaces, in the years 1912-1920, together with an estimate of the cost in September last:—

Table II.—*Comparison of Wages Paid to Colliers, Blast furnacemen, and Steelworkers per ton of Steel Plates.*

	Colliers.	Blast-furnacemen.	Steel-workers.	Total.
1912 ..	37.5	10.5	52.0	100.0
1913 ..	46.7	10.9	64.9	122.5
1914 ..	52.5	11.7	61.4	125.6
1915 ..	58.4	12.6	67.7	138.7
1916 ..	81.3	16.3	88.6	186.2
1917 ..	102.6	19.5	99.4	221.5
1918 ..	147.7	24.9	130.0	302.6
1919 ..	250.2	40.3	186.8	477.3
1920 ..	296.4	52.6	218.0	567.0
Sept., 1922*	73.0	23.5	113.3	209.8

*Estimated.

As a contrast to the comparison of the nominal wages costs (in money value) given above, another comparative set of figures has been prepared (see Table III.), showing the equivalent "real" wages costs (in commodity value). This is obtained by altering the money value into purchasing value in accordance with the average of the Board of Trade "cost of living" figures for each year.

Table III.—*Comparison of Purchasing Power of Wages Received by Colliers, Blast-furnacemen, and Steelworkers per ton of Steel Plates.*

	Colliers.	Blast-furnacemen.	Steel-workers.	Total.
1912 ..	37.5	10.5	52.0	100.0
1913 ..	46.7	10.9	64.9	122.5
1914 ..	51.4	11.5	60.1	123.0
1915 ..	47.4	10.2	54.9	112.5
1916 ..	55.6	11.1	60.6	127.3
1917 ..	58.2	11.0	56.3	125.5
1918 ..	72.6	12.2	64.0	148.8
1919 ..	116.3	18.7	80.8	221.8
1920 ..	119.2	21.1	87.7	228.0
Sept., 1922* ..	40.8	13.1	63.3	117.2

*Estimated.

These figures are prepared from actual yearly results, and, of course, they include the effects of many different causes. During some of the years costs were increased by strikes, such as the railway strike, the bricklayers' strike (in steelworks), the first miners' strike, and so on. But the costs of strikes are rightly included, as they must ultimately be borne by the industry.

During the war, and after it, wages costs were very seriously increased by the dirty and unsuitable fuel which had to be used, and the figures given in Table IV. make this obvious:—

Table IV.—*Comparison of Consumption of Raw Materials and Production at Blast Furnaces.*

	Ore used.	Coal used.	Limestone used.			Output per furnace
			To flux ores.	To flux fuel.	Total.	
1912 .	100.0	100.0	—	—	100.0	100.0
1913 .	98.3	103.8	—	—	112.7	103.1
1914 .	98.5	106.8	—	—	122.1	102.8
1915 .	99.6	109.9	33.3	89.0	122.3	95.5
1916 .	100.2	115.7	30.5	90.1	120.6	91.7
1917 .	97.9	113.6	49.7	93.4	143.1	88.2
1918 .	99.7	116.3	60.1	106.4	166.5	83.6
1919 .	101.1	125.3	50.9	137.6	188.5	80.7
1920 .	102.2	122.6	52.6	132.0	184.6	84.0

Table V.—*Comparison of Consumption of Fuel in Steel-Works per Ton of Plates.*

	Producers.	Boilers.	Cranes, etc.	Total.
1912 ..	66.0	30.3	3.7	100.0
1913 ..	78.9	24.3	4.4	107.6
1914 ..	80.7	24.0	3.6	108.3
1915 ..	79.8	21.4	4.4	105.6
1916 ..	88.0	24.2	5.3	171.5
1917 ..	93.7	24.9	4.8	123.4
1918 ..	101.8	34.0	5.2	141.0
1919 ..	108.9	36.1	5.7	150.7
1920 ..	106.4	35.1	3.6	145.1

Again, wages costs are influenced by sliding-scale movements. Such scales, though nominally representing prosperity in the industry or the reverse, were made to rise during the war by causes which did not really reflect such prosperity. The result was that many wage rates, in their proportion to pre-war rates, greatly exceeded the cost of living figures. Not only "nominal" but "real" wages were very much increased. But the iron and steel trades were wise not to allow any interference with sliding scales, and, on the contrary, to largely extend the number of men whose wages were regulated in that way. We sometimes boast that our trade can give an example to all other trades in our methods of regulating wages. Sliding scales do not form a perfect system of profit sharing, but they seem to be the only system which has successfully stood the test of time.

Output has necessarily an influence on wages costs, as the time-wages cost must vary inversely as the output. In steelworks the influence of output and sliding scales can easily be expressed in an equation. Thus in each department:—

$$\text{Wages cost per ton} = \text{Tonnage base wages cost per ton} \left(1 + \frac{\text{melters scale percentage}}{100}\right) \pm \frac{\text{Stand'rd output}}{\text{Actual output}} \left\{ \begin{array}{l} A\left(1 + \frac{\text{melters scale percent'ge}}{100}\right) \\ +B + \lambda. \text{ melters scale percentage} \\ +C + \mu. \text{ engineering trade war bonus} \\ +D + \nu. \text{ building trade "fodder" bonus} \end{array} \right\}$$

Where

A = base time wages cost per ton of standard output of straight scale men.

B = base time wages cost per ton of standard output of men on "stepping scheme."

C = base time wages cost per ton of standard output of tradesmen other than building trade.

D = base time wages cost per ton of standard output of building tradesmen,

and λ, μ, and ν are constants to be determined.

Yields have a big influence on wages costs. The question of yields is under the control of the technical staff. It is easy to draw up a formula which shows the effect of yields upon wages cost. By applying this formula in a particular case it has been found that the difference due to a fairly normal variation of yield was equivalent in wages cost alone to a difference of forty men in the staffing of the plant.

$$\text{Wages cost of plates} = \frac{100}{\text{yield of plate}} \times \left\{ \frac{100 \times \text{Ingot wages cost}}{\text{yield of slab}} + \frac{\text{wages cost at cogging mill}}{} \right\} + \frac{\text{wages cost at plate mill}}{}$$

From these two equations, if the constants be once calculated for the standard output, it is possible in a very few minutes to forecast the wages cost in any possible circumstances of output, yield, and scale movements.

There is much confusion in the minds of the manual workers between the rate of wages paid and the wages cost. Naturally the workman is mainly interested in what he takes home on Friday night. But the consumer is not at all concerned with what is in the individual "poke," but with the cost per ton which the manufacturer has to bear and pass on to him. While wages rates in the trade have generally come down to a point below the official cost of living figures, a careful estimate of wages costs shows that they are still all above the Board of Trade percentages in their relation to pre-war costs. This, of course, is explained by the lower production per employee due to the shorter working day, which is brought out in Table VI.:—

Table VI.—*Output Per Employee per Annum in Tons.*

	Pig-iron.	By-products.	Steel.
1912	382.3	317.4	106.8
1913	350.3	346.2	79.4
1914	320.6	349.2	88.7
1915	385.8	315.9	102.3
1916	334.9	330.2	80.6
1917	330.9	330.1	88.3
1918	315.8	347.5	89.3
1919	245.5	288.3	50.8
1920	226.3	270.0	59.0
1921*	254.0	—	—

* Rate per annum for 3 months.

The shorter hours were introduced in the spring of 1919.

The aim of each employer should be to endeavour to keep individual wages up as far as is reasonable, and at the same time to reduce his wages cost. A certain amount can be done in this direction by improved technical methods and plant, which would cause an increased production per man, but at the moment there is no prospect of such radical changes of that kind as would compensate for the increased cost of the shorter working hours. For certain particularly hot and heavy jobs one is bound to have every sympathy with the present working hours, but it is not clear how it is possible that men can retain their pre-war standard of living with 37½ hours work per week on jobs which do not require any great physical or mental exertion. This point may be stressed by some simple figures. In July, 1914, the blast-furnace labourers' shift wage was equal to 14⅔ 2-lb. loaves per shift. To-day it is equal to 16 loaves per shift, and a much shorter shift. In 1914 it meant a loaf for every 49 minutes; to-day a loaf for every 30 minutes. Coming to wages cost, in 1914 the cost per ton of all labour at the blast furnaces was equal to 19½ loaves per ton; to-day it would be 27 loaves per ton. Where are the 7½ loaves to come from? The consumer won't provide them, because he has got the same idea about working shorter hours for the same wages for himself, and he only wants to provide 13 loaves instead of the 19½ which he provided before the war. Not until this conundrum is solved can we see any real hope of a revival of industry.

Some slight reduction in cost might be brought about by a wider application of payment by results. It is generally considered that in the iron and steel trade payment by results is of general application, and it is rather surprising to find that in reality a comparatively small amount of total wages paid consists of tonnage payments.

One further source of relief is by using to the best advantage every possible by-product; in fact, no industry to-day can live without taking full advantage of such sources of revenue. There was a danger within the past few weeks of one such small source being cut off from iron and steel works, owing to the demand made for assessment of slag-heaps as heritable. However, the Valuation Committee evidently saw that they would hurt themselves as much as anyone else if they agreed with the assessor's point of view. The various local authorities are some of the principal users of material of this kind, and no doubt before long they themselves would have to pay at least the tenant's share of the rates.

Catalogues Received.

The Globe Pneumatic Engineering Company, Limited, 1, Victoria Street, London, S.W.1.—This catalogue has considerable interest for foundrymen, as it deals in an interesting way with air compressors, about which foundrymen cannot know too much.

The Adams Company, Dubuque, Iowa, U.S.A.—A series of pamphlets outlining the different foundry equipment which they manufacture. Amongst their specialities, probably the most interesting is the Farwell moulding machine.

The Watson Metallurgical Company, Lancaster Street, Sheffield, are this year sending to their friends a handsome Diary for 1923.

J. D. Wallace & Company, 1401, W. Jackson Boulevard, Chicago, U.S.A.—A handsome illustrated catalogue outlining a number of interesting specialities for the pattern shop, amongst which they show an automatically electrically heated glue-pot. For the foundry there is an electric sifter.

The C. O. Bartlett & Snow Company, Cleveland, Ohio, U.S.A.—A beautifully illustrated catalogue containing photographs and diagrams of typical installations they have erected in various foundries of mechanical sand-handling plants, continuous moulding equipment, and mechanical carrying arrangements.

The Stoic Steel & Tool Company, Limited, Self Hard Works, Cornish Street, Sheffield, are paying a first and final dividend of 2s. 1d. in the £.

The last day for receiving proofs in connection with a dividend to be paid by Mr. S. Sanders, iron and steel merchant, Lower Cross Street, and Rolfe Street, Smethwick, is December 29.

The creditors of Mr. H. G. W. Cooling, 10, Market Street, Worksop, joint managing director of Cooling & Lee, Limited, of Worksop, and White Buildings, Fitzalan Square, Sheffield, engineers, met at the Official Receiver's offices, Sheffield on December 13, when they decided to leave the matter in the hands of the Official Receiver. The debtor, who stated that his failure was due to "bad trade and lack of capital," had a deficiency of £373.

Trade Talk.

Mr. Henry Mechan, of Scotstoun, has given £25,000 for a Chair of Public Health at Glasgow University.

The late Mr. A. J. Evans, proprietor of William Evans, Son, & Company, brass founders, etc., Wolverhampton, left £12,936.

The Yorkshire Copper Works, Limited, Leeds, have established a London office at 53, New Broad Street, E.C.2.

Loudon Brothers, Limited, have removed from 110, Cannon Street, London, E.C., to Abbey House, 2/8, Victoria Street, S.W.1.

Considerable damage was done by a fire which broke out in the dockyard of Scott's Shipbuilding and Engineering Company, Limited.

Frederick Fox, Limited, engineers, have removed from 76, Thornton Road, Bradford to the Central Ironworks, Bowling Back Lane, Bradford.

Mr. F. Robinson, of 3, New Street, Birmingham, has been appointed agent in the Midlands for Mullier, Roosen & Company, iron and steel merchants, Brussels.

Alder and Mackay, Limited, brass founders and meter manufacturers, of Edinburgh, have removed their London branch to Douglas Street, Westminster, S.W.1.

The Power Engineering Company, Limited, of Westinghouse Road, Trafford Park, Manchester, have been appointed British agents for the U.S. Smelting Furnace Company, Belleville, Ill.

The Enterprise Engineering Company, Limited, are being wound up voluntarily. Mr. W. R. K. Palk, 56, Newhall Street, Birmingham, has been appointed liquidator.

The Blyth Shipbuilding and Dry Docks Company, Limited, launched four vessels of 11,300 tons and 7,050 i.h.p., in addition to considerable repair work, during the past year.

The late Mr. H. G. King, of Copers Cope Road, Beckenham, Kent, a director of Kasenit, Limited, manufacturers of case hardening materials, Ludgate Square, E.C., left £4,813.

In connection with the Yorkshire Association of the Institution of Civil Engineers, Mr. G. B. Jones read a paper on "Corrosion" before a meeting held on December 15 at Leeds.

Vickers, Limited, launched from the Barrow Shipyard this year three vessels of a total gross tonnage of 21,342, and the total horse power constructed was 12,000. The figures for last year were 64,320 tons, and 46,350 horse power.

The members of the South Wales branch of the Institution of Mechanical Engineers met at Swansea last week, Mr. David E. Roberts (Cardiff) in the chair. A paper was read by Mr. Josiah Butler on "Gas Producers."

W. T. Henley's Telegraph Works Company, Limited, Blomfield Street, London Wall, London, E.C.2, have removed their Bristol branch from 56, Victoria Street, to 11, Nelson Street, Bristol. The branch is under the managership of Mr. E. H. Brown.

"Modern Forging Methods" was the subject of a lecture given in the Mappin Hall, Applied Science Department, of the Sheffield University, on December 14, by Mr. J. G. Gillott, in the absence of Mr. A. B. Wilson. The lecture was under the auspices of the Sheffield Tool Trade Technical Society.

It is reported that a group of financiers is seeking to effect a combine in the textile machinery industry. The combine, if formed, will, it is rumoured, embrace Platt Bros., Asa Lees & Company, Howard & Bullough, Dobson & Barlow, J. Hetherington & Sons, and possibly two or three smaller concerns.

The Fuller Engineering Company, 25, Victoria Street, Westminster, London, S.W.1, have obtained another contract for a complete pulverised coal installation to a boiler plant of nearly 5,000 H.P. capacity, and also an order for a further set of their pulverised coal equipment for application to locomotives.

Hyam, Limited, 56, Victoria Street, London, S.W.1, have appointed a member of their staff, Mr. G. A. Chapman, to represent them in Manchester and district. The Company's representation for that district was previously held by Martin Bros., Limited, 35, Bridge Street, Manchester.

The Cundall Folding Machine Company, associated with W. & P., Limited, founders, mechanical and electrical engineers and merchants, have removed their sales office from 240, High Holborn, London, W.C.1, to Fengate, Peterborough. The London representation is in the hands of Russell & Company, 63, Queen Victoria Street, E.C.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to the undermentioned concerns:—H. Bickersteth, trading as Bickersteth, Baker and Company, 17, Water Street, Liverpool; A. Keating, Gorton Street, Rochdale Road, Manchester; Ricard and Freiwald, 120, Fenchurch Street, London, E.C.3; C. W. Taylor and Son, 5, The Green, Darlaston.

Daniel Adamson & Company, Limited, turbine engineers and boiler makers, of Dukinfield, announce that their works will be closed for the Christmas holidays from Friday, December 22, until Wednesday, December 27. For the New Year holidays their works will close on Friday, December 29, 1922, until Tuesday, January 2, 1923. No goods will be received or despatched between these dates.

The contract for the excavations connected with the large extensions which are to be made by Stewarts and Lloyds, Limited, at their Clydesdale Works, Mossend, has now been placed, and work is about to be started. An order has been placed with Ruston and Hornsby, Limited, of Lincoln, for the supply of two of their excavators mounted on caterpillar tractors. These will be supplemented by three other shovels from the contractors own stockyards.

Mr. T. Phillips, secretary of the South Wales and Monmouthshire Iron and Steel Manufacturers' Association, announces that the joint auditors' report for the three months ending November 30 shows a reduction under the sliding scale of 25 per cent., which means that as and from January 1 to March 31, 1923, the wages of the workmen, following the scale, will be 50¾ per cent. above standard as compared with 51 per cent. at present.

The members of the Sheffield Branch of the Institution of British Foundrymen met at the Cutlers' Hall Sheffield, on December 15, when several types of moulding machines were described. The president, Mr. T. Swinden, who was in the chair, said the meeting had some element of novelty in it, as representatives were present who would describe various types of moulding machines. These were Mr. Daniel Sharpe (Foundry Plant & Machinery Company, Limited, Glasgow), Mr. F. E. Steele (Macdonald & Company, Glasgow), Mr. F. Shearman (Adaptable Moulding Machine Company, Birmingham), and Mr. J. W. Rawlinson (J. W. Jackman & Company, Manchester).

Professor H. S. Hele-Shaw presided at the seventy-fifth anniversary dinner of the Institution of Mechanical Engineers on December 15. Those present included Sir Charles S. Sherrington, Sir Thomas H. Holland, Mr. William H. Patchell, Major-General Sir H. W. E. Parsons, Sir Richard T. Glazebrooke, Mr. C. T. Musgrave, Mr. David E. Roberts, Mr. Henry Davey, Mr. H. E. Yarrow, Sir Arthur I. Durrant, Lieutenant-Colonel E. Kitson Clark, Sir Herbert J. Creedy, Sir Archibald C. Ross, Sir Robert A. Hadfield, Sir Sydney Chapman, Mr. Daniel Adamson, Mr. L. Sumner, Professor Thomas Turner, and Mr. F. W. Harbord.

The Engineers' Section Sub-Committee of the Committee for the Relief of Russian Intellectuals, of which Sir Robert Hadfield, Bart., is hon. president, and Professor H. C. H. Carpenter honorary vice-president, are making an appeal on behalf of Russian engineers. So serious are the conditions under which Russian men of science are placed and so pressing their wants that the members of the committee feel it incumbent upon them to bring to the notice of members of the British engineering profession the acute distress prevailing amongst their colleagues in Russia. Amongst the sufferers, there are many families of members of the civil, electrical, mechanical, mining engineers and metallurgists. Their plight is heart-rending, for owing to the stagnation of industry there is almost a total lack of employment. The hon. treasurer of the fund is Mr. R. C. Griffith, 8, Victoria Avenue, Bishopsgate, E.C.2.

A meeting of the Welsh Engineers and Allied Trades Conciliation Board was held at Swansea on December 15 to further consider the question of the demand for wage reductions, submitted some time ago, which would affect craftsmen and semi-skilled men employed at the foundries located between Port Talbot and Llanelly, and craftsmen employed at the South Wales tinplate works and Siemens steelworks. After discussion the employers made an offer which they desired to impress upon the men's representatives must be accepted as final:—That skilled men be paid as from January 1, 1923, and be operative to the end of June, £3 7s. 6d. per week, or a reduction of 6s. per week, and unskilled £2 10s. per week, or a reduction of 5s. per week. Failing acceptance, arbitration in accordance with the constitution of the Conciliation Board. The delegates agreed to recommend the acceptance of the conditions offered to the men, who are instructed to ballot upon acceptance or arbitration.

Taberg Iron Ore.—According to a Swedish report the Germans are again taking an interest in Taberg iron ore. Mining at Taberg ceased at the end of last century, and German interests have more than once planned a resumption of activity. It is intended to transport the ore to Germany, or possibly to smelt it at Halmstad. The Nässjoe Railway, it is stated, would be able to transport 1,000 tons daily to Halmstad.

IRON AND STEEL MARKETS.

Pig-iron.

The concluding markets for the year have brought little change in the pig-iron position, which remains as previously reported, firm with a steady expansion in home consumptive demand, and a by no means negligible, if diminished, volume of export trade. That there is an increased inquiry for foundry iron is unquestionably evidenced in the Lancashire area, an important centre of that particular industry, the Manchester market for pig showing a distinct if slow improvement, though buying is, as yet, only on a limited scale. In this district, as in others, hopes were entertained by consumers of some reduction in quotations, consequent upon the recent revision of rail transport rates in a downward direction. Smelters, on the other hand, contend that production costs hitherto have precluded anything like remunerative working, and that any small saving effected by the cheaper terms for carriage of raw material, etc., should be to the advantage of the producer. Here also there is a tendency to increase in the competition of the Northamptonshire with Derbyshire foundry iron, resulting from the lower railway carriage from the farther sources of supply, but this is not yet very noticeable. The feeling that pig-iron is now at about the lowest level which it is likely to reach is perhaps attributable to the fact that for a long time there has been no "bear" selling of iron in this or indeed in any other district. One does not find people interested in depressing the value of pig-iron, and hence opinion is all one way. At Birmingham market last week fairly satisfactory reports were heard concerning foundry iron, demand for which is on an increasing scale, and quotations are very firm. Altogether conditions look much more promising than they have done for a long time. Quotations :—Northamptonshire forge iron, 70s. to 72s. 6d.; No. 3 foundry, 77s. 6d. to 80s.; Derbyshire forge, 75s.; No. 3 foundry, 82s. 6d.; all f.o.t. furnaces. The Cleveland iron market has been much quieter as the close of the year draws near, and stocks in makers' yards have tended to accumulate, more especially in the case of forge and foundry qualities. Prices have accordingly weakened to a slight extent, No. 1 and silicious being quoted at 95s., and No. 3 G.M.B. at 91s., though some makers are holding out for 92s. No. 4 foundry is at about 85s., and No. 4 forge at 82s. 6d.

The demand for hematite continues unabated, and it is occasionally difficult to obtain prompt deliveries, the increased production of steel practically absorbing current outputs. Prices consequently show a firmer tendency all round, with last week's quotations ruling for East Coast mixed numbers at 93s., with a premium of from 6d. to 1s. per ton for No. 1 quality, while West Cumberland Bessemer brands remain steadily at 105s. to 110s., delivered Glasgow or Sheffield.

Finished Iron.

A distinctly more cheerful note was sounded at last week's meeting of the South Staffordshire iron trade, and as far as finished material is concerned the prevailing impression appeared to be that conditions are at last improving. Perhaps the most conclusive evidence on the point is furnished by the fact that manufacturers are beginning to get some accumulation of orders on their books. That is the most encouraging and hopeful sign as to the future which it is possible to have. For a very long time now consumers have been buying from hand to mouth. That they have changed their attitude is due to two things—their own order books are more healthy, and a feeling that the market has reached bottom. Marked bar makers are fairly well off for orders, and quotations for these qualities remain remarkably firm and steady, foreign competition affecting more directly producers of the commoner brands of iron. There is now a somewhat improved demand for crown quality bars, but business in this section is far from being as brisk as could be desired. Quotations all round remain firm at previous levels.

Steel.

After a period of unprecedented depression, it is satisfactory to report that the close of 1922 marks an improvement in the conditions of the steel trade of the country, as evidenced in a welcome revival of home demand and a corresponding movement in the export business passing. Further progress in the last-named direction will undoubtedly be accelerated by the exchange position on the Continent, few of the Belgian or French works caring to accept anything but comparatively small orders, and those for delivery early next year. As a result, some business has been diverted to British steel works, although a greater tonnage of orders has been held in suspense pending a possible revival of Continental competition. As the home steel markets will be practically closed over the next fortnight for holiday and stock-taking purposes, current business will be almost entirely suspended, but quotations are generally firm without much expectation of any change of importance in the meantime. In the ferro-alloy market silico-manganese has been inquired for in fair quantities, and the price is firm, ruling about £17 per ton for material showing 50/55 per cent. Mn contained. For higher content, the price appreciates at approximately 2s. per unit increase in the Mn. contained The silicon contained is generally between 20 and 25 per cent., although material showing only 15/20 per cent. Si has been asked for. The demand for tinplates continues steady, and makers have decided, owing to the advance in the price of steel, to fix the minimum price at 20s. per standard box f.o.b. Bristol Channel ports, for future delivery.

Scrap.

There is very little to add to previous reports on the conditions in the scrap metal trade, business everywhere having quietened down in view of the impending holidays, but with a distinctly better outlook than could have been anticipated a short time ago. The firmness of prices for certain qualities of iron and steel scrap noted of late is well maintained, as expressed in the following quotations for sales recently effected in the Middlesbrough market. Prices for heavy steel scrap are 68s. 6d. per ton; heavy cast-iron scrap, machinery quality, in handy pieces, 75s. to 77s. 6d. per ton, delivered works; good heavy steel turnings and good clean cast-iron borings, 55s. per ton, delivered works; heavy wrought-iron scrap, ordinary piling quality, 72s. 6d. per ton, delivered works; and good heavy forge iron scrap is quoted 80s. per ton.

How the A.F.A. Papers are Produced.

Whilst the difference between the Institution of British Foundrymen and the American Foundrymen's Association is patent on account of one catering for a continent and the other a country, the fundamental difference is narrowing, as a perusal of the I.B.F. list of members will show. It includes now Indian, Australian, American, French, Belgian and Spanish adherents; and such people may like, but fear, to ask permission to present a Paper. Thus excellent work may never come to light. Our American cousins overcome this difficulty by issuing to all members the following form:—

RETURN BLANK.

To the Secretary of the Papers Committee,
American Foundrymen's Association.

The undersigned hereby offers to present a Paper on .....
.....
.....
at the annual meeting of the Association to be held in the Spring of 1923.

It is understood that the acceptance of this offer does not imply an obligation to accept the Paper if it should fail to conform to the Regulations Governing Papers.

The undersigned expects to be able to furnish the manuscript of the Paper complete (including tabular matter and illustrations, if any) within (name shortest time).....weeks from the date of the receipt of the acceptance of this offer.

It is suggested that the following persons (give names and addresses) be invited to open a discussion on the above subject:—
.....
.....

It is also suggested that the following persons (give names and addresses) be requested to present Papers on the subjects named below:—
.....
.....
.....
.....

The following are suggested as desirable subjects for a Paper or Discussion:—
.....
.....
.....

Signed.....

You are urged to lend your co-operation by filling out this blank and mailing to the address above as promptly as possible.

The British Cast Iron Research Association.

Progress of Research Work in Hand.

In his monthly circular the director, Dr. Percy Longmuir, states that during December arrangements have been made for the early prosecution of definite and systematic research on some of the fundamental properties of cast iron.

The range of irons to be examined in the first place will include the full run of commercial grey irons and semi-steels. Special reference will be given to liquid shrinkage and solid contraction as outlined in Research No. 8—"Shrinkage Defects."

This side of the work will be further supplemented by a correlation of chemical, mechanical, physical, thermal, structural, and magnetic properties.

In reference to thermal properties, it is intended specially to investigate volume changes due to temperature, the critical ranges and the effect of initial temperature on these ranges, and to follow up with a systematic investigation of the physical properties of commercial grey cast irons at temperatures higher and lower than atmospheric. This, when completed, will give results of real and direct value in the case of all types of castings which in working life are subjected to abnormal temperatures. These studies will also include the effect of repeated reheating, and the practical foundry value will lie in the direction of developing types of cast iron adaptable for abnormal temperature working conditions.

An opposite property, that of resistance offered to various corrosive agents, will also be studied, and at the request of one member special reference will be given to the action of sea water on cast iron. As this section progresses it is hoped to examine the special alloy cast irons and later to investigate the possibilities of machinable non-corrosive cast irons.

The work contemplated is extensive and will naturally occupy a considerable time. However, the very willing offers of co-operation already received will go far in facilitating real progress. When complete the work will present evidence of practical foundry value. Further, this work will pave the way to a systematic study of the white irons and malleabilisation.

In the meantime, a preliminary investigation is being conducted on some of the difficulties of malleable cast-iron practice, and the results will be issued to members in due course.

Problems Sent in by Members.

Minor investigations in regard to members' difficulties are being actively followed, and in this respect the Director will welcome suggestions and instances of either abnormal melting practice or abnormal castings. Reports have been made to members during the past month upon the following problems: Semi-steel difficulties; mixtures for semi-Diesel engine castings; cast-iron tank plates; malleable cycle-hub castings; cast-iron carburettor castings; physical properties of malleable cast iron; mixture for cast-iron cylinders.

Membership.

During the past month further new members were elected. The support the Association is now obtaining is very gratifying evidence that the industry is waking up to its responsibilities. A new booklet has now been issued giving the full conditions of membership, which will be forwarded to any foundry interested.

Deaths.

Mr. B. S. Broadhurst, managing director of the Brush Electrical Engineering Company, Limited, died on December 11.

Mr. Shelper, commercial manager to the Crown Preserved Coal Company, Limited, of Cardiff, died recently in his 49th year.

Mr. C. F. G. Gough, managing director of the Fairwood Tinplate Company, Limited, died recently at his residence at Gower, near Swansea.

Mr. T. L. Greenwood, of Edgedale Road, Sheffield, secretary of the firm of T. W. Ward, Limited, Albion Works, has died in Sheffield after an operation. Mr. Greenwood has been secretary of the company since its incorporation in 1921.

Company News.

J. Atkinson & Company, Limited, 11, Blackfriars Road, Salford, Manchester.—Capital £5,000 in £1 shares. Metal merchants. Directors: J. H. Atkinson, C. F. Atkinson and J. R. Wallwork.

Atlas Engineering & Foundry Company, Limited.—Loss, £13,791; brought in, £3,992; debit balance carried forward, £9,798.

Busk Textile Machinists, Limited.—Capital £1,000. Directors: A. W. Thomas (permanent governing director) and R. J. Thomas.

Bertrams, Limited.—Brought forward, £5,084; net profits, £9,889; dividend, 10 per cent.; depreciation account, £3,000; carry forward, £2,389.

E. Binns & Sons, Limited, West Vale, near Halifax.—Capital £5,000 in £1 shares (2,000 6 per cent. cumulative preference). Millwrights and mechanics. Permanent director: J. E. Binns.

Channel Steel Company, Limited.—Debit to administrative and other expenditure account increased from £21,094 to £22,032. During year directors unable proceed with development of properties, but matter now having attention.

Eltringhams, Limited.—Profit, £21,999; depreciation, £11,522; set aside for E.P.D., corporation profits tax and income tax, £30,887; adverse balance, £20,480; brought forward, £39,435; credit balance carried forward, £18,955.

Gibbons (Dudley), Limited.—Further interim ordinary dividend, 3½ per cent., making 7 per cent. for year, free of tax.

James Hinks & Son, Limited.—Net loss for year, £6,027; credit balance brought in converted into debit, £2,576. Loss arrived at after including £13,176 E.P.D. recoverable and £36,880 taxation reserve no longer required.

Howard & Bullough, Limited.—Quarterly dividend, 6d. per share, less tax, on ordinary and preference.

Milners' Safe Company, Limited.—Interim dividend, 2½ per cent., less tax.

G. D. Peters & Company, Limited.—Quarterly preference dividend, 6 per cent. per annum, less tax.

Ropner Shipbuilding & Repairing Company (Stockton), Limited.—Capital £200,000 in 5s. shares (600,000 preferred ordinary and 200,000 deferred ordinary), to adopt agreements with the Ropner Shipbuilding and Repairing Company (Stockton), Limited (in liquidation), and J. G. Johnson. Directors: Sir William H. Seager, Lord Glanely, Sir William Reardon Smith, Bart., John Cory, W. Leon, T. H. Mordey, T. E. Morel, Sir Archibald Mitchelson, Bart., E. H. O. R. Ropner, jun., and Leonard Ropner. Secretary: H. J. Fowler.

John Spencer & Sons, Limited.—Credit balance, including £42,038 brought forward, £30,738; renewals and improvements expenditure, £15,000; carry forward, £15,738.

Taft-Peirce Company, Limited, 2, Gresham Buildings, Basinghall Street, London, E.C.2.—Capital £100. Civil and mechanical engineers, etc. Permanent directors: F. S. Blackall, G. Gordon and F. W. G. Snook.

F. E. Vickers & Company, Limited, 23, Telegraph Buildings, Sheffield.—Capital £1,000 in £1 shares. Mechanical, electrical and general engineers. Directors: R. H. Piggford (managing) and F. Vickers.

Contracts Open.

Bradford, January 1.—Stores, for the Tramways Committee. Mr. R. H. Wilkinson, tramways general manager, 7, Hall Ings.

Dublin, January 4.—Supply of aluminium, brass, etc., lead and spelter castings, etc., for the Commissioners of Irish Lights, Dublin. Mr. J. B. Phelps, secretary.

Llandebie, January 4.—Supply of cast-iron pipes, valves, fittings, etc., for the Llandilofawr Rural District Council. Mr. G. H. Davies, College Street, Ammanford. (Fee, £5 5s., returnable.)

New Hunstanton, January 3.—Supply of 80 tons of 6-in., 4-in., and 3-in. cast-iron S. and S. pipes and specials to comply with the British standard specification, Class "B," for the New Hunstanton Urban District Council. Mr. F. Wilkinson, engineer and surveyor, Town Hall, Hunstanton.

Okehampton, January 8.—Supply, laying and jointing of about 1,000 yards of 5-in. and 4-in. cast-iron socket pipes, etc., for the Town Council. Nichols & Unwin, 11, Victoria Street, Westminster, S.W.1 (Fee, £2, returnable.)

Cigny.

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FEB 15 1923

THE

FOUNDRY TRADE JOURNAL

THE IRON & STEEL TRADES JOURNAL.

OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN.

Vol. 26. No. 332.] DECEMBER 28, 1922.

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		Soft.	Medium	Hard.	Soft.	Hard	Mottled.	White.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Iron	91.57	92.21	92.31	92.46	92.83	93.75	93.85	94.14
Graphite	3.25	3.00	2.98	2.90	2.95	2.60	2.00	0.60
Combined Carbon	0.18	0.23	0.33	0.45	0.50	0.60	1.50	2.80
Silicon	3.25	2.80	2.60	2.40	2.00	1.40	0.90	0.56
Sulphur	0.02	0.03	0.05	0.06	0.07	0.10	0.15	0.30
Phosphorus	0.80	0.80	0.80	0.80	0.72	0.70	0.70	0.70
Manganese	0.93	0.93	0.93	0.93	0.93	0.85	0.90	0.90

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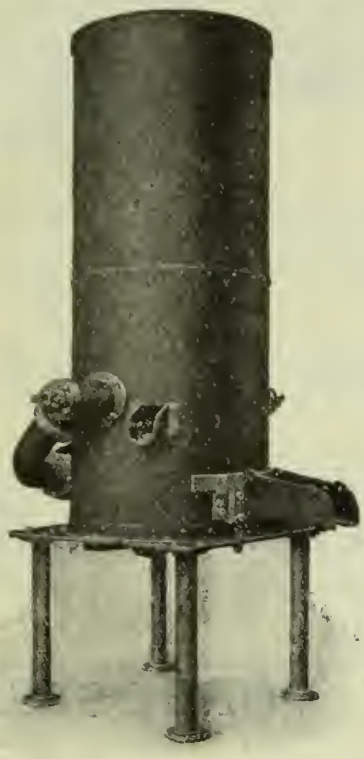

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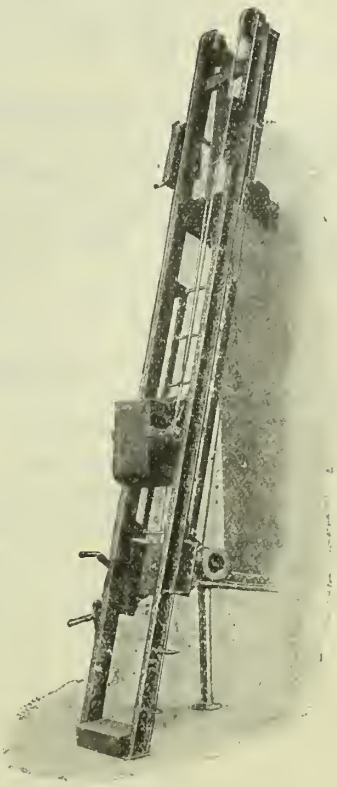

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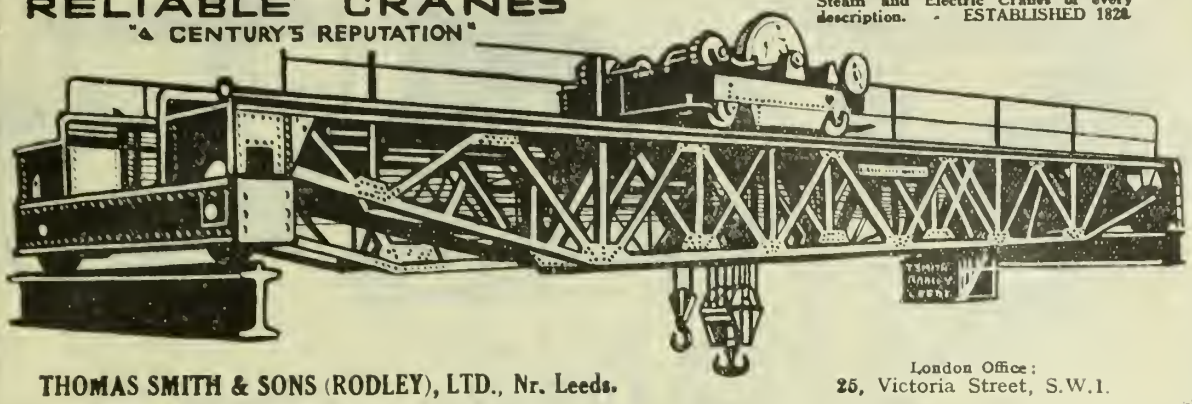

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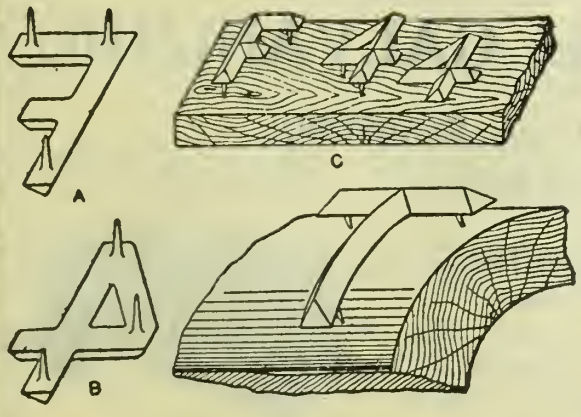

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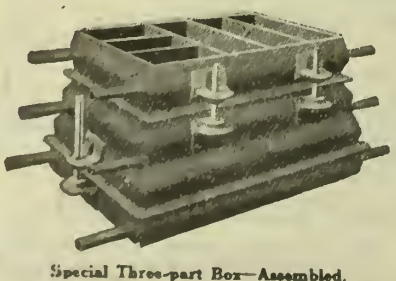

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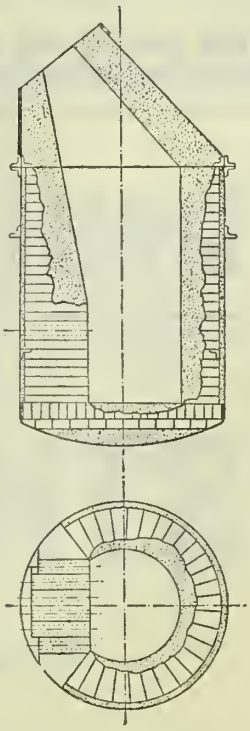

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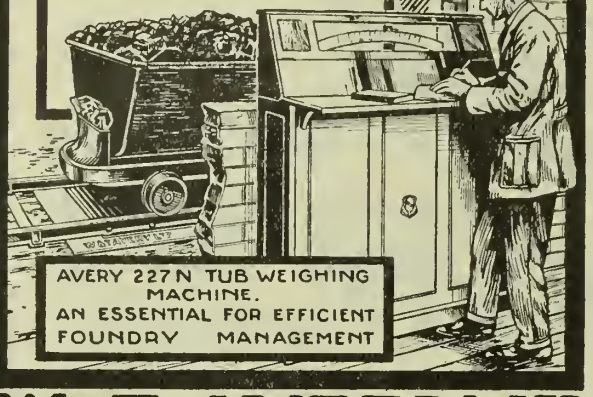

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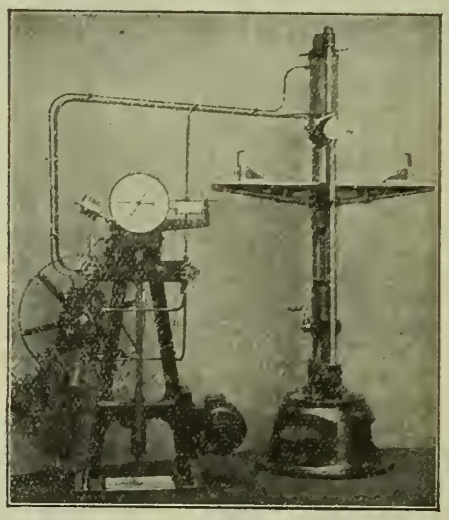

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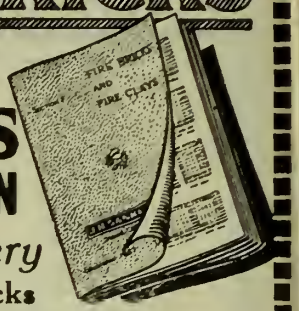

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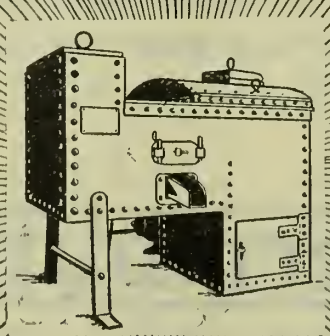

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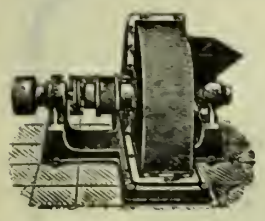

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INDEX TO ADVERTISERS.

	Page
Allan, Thos., & Sons, Ltd.	16
Amsler, Alfred J., & Co.	10
Armitage Works Co.	—
Aske, Wm., & Co.	12
Asquith, Wm. (1920), Ltd.	—
August's Muffle Furnaces, Ltd.	—
Avery, W. T., Ltd.	10
Baldwins, Ltd.	1
Bartoline (Hull), Ltd.	20
Baxter, W. H., Ltd.	—
Beardmore, Wm., & Co., Ltd.	—
Beecroft & Partners, Ltd.	21
Blackfriars Foundry Requisite & Equipment Co.	—
Brealey, W., & Co., Ltd.	15
Britannia Foundry Co.	—
British Reverberatory Furnaces, Ltd.	14
British Thermit Co., Ltd.	—
Brookes (Oldbury), Ltd.	16
Buckley & Taylor, Ltd.	—
Bullivant & Co., Ltd.	—
Butterworth Bros., Ltd.	16
Cammell, Laird & Co., Ltd.	—
Carbic Ltd.	16
Clay Cross Co., Ltd.	30
Cleveland Magnesite & Refractory Co., Ltd.	20
Collin, A.	—
Colville, D. & Sons, Ltd.	21&30
Consett Iron Co., Ltd.	1
Constructional Eng. Co., Ltd.	—
Crispin & Co.	—
Crosby Valve & Eng. Co., Ltd.	22
Cumming, Wm. & Co., Ltd.	—
Davidson & Co., Ltd.	17
Davies, T., & Son	—
Denby Iron & Coal Co., Ltd.	3
Dearman, E., & Sons	—
Dixon Crucible Co. (The Joseph)	—
Dowler, H. J.	—
Dudley Docker	1
Dudley & Dowell	—
Durrans, J., & Sons	—
Dyson, J. & J.	—
Evans, J., & Co., Ltd.	—
Findlay, A., & Co., Ltd.	—
Fordath Engineering Co., Ltd.	11
Foster Bros., Ltd.	26
Furmston & Lawlor	26
Fyfe, J. R., & Co.	—
Gadd, Thos.	—
General Refractories Co., Ltd.	27
Gibbons Bros., Ltd.	22
Gibson, Arthur L.	15
Gillott, J., & Sons	—
Goldendale Iron Co., Ltd.	—
Gossell & Son, Ltd.	—
Grandidge & Mansergh	—
Gray, Thos. E., & Co.	—
Great Central Railway Co.	—
Green, George, & Co.	—
Grundy, John, Ltd.	—
Guest, Keen & Nettlefolds, Ltd.	—
Hall, C. E. V.	24
Hall, J., & Co. (Stourbridge), Ltd.	19
Hall, Lewis & Co.	28
Hall & Lund Bros.	17
Hammond Alex.	20
Harper, Wm., Son & Co.	—
Harris Bros. (Brierley Hill)	4
Harvey, E. W., Gas Furnace Co., Ltd.	—
Hawkins, W. T., & Co.	—
Hingley, N., & Sons, Ltd.	29
Hope Works Co., The	—
House, Fredk., & Co.	24
Hunt, F. L., & Co.	29
International Abrasives Ltd	—
Jacks, William, & Co.	19
Jacks, Wm., & Co., Ltd.	—
Jackson & Brother	26
James, Wm.	27
Jones, Geo., Ltd.	27
Jordans Ltd.	—
Keith (James) & Blackman Co., Ltd.	—
KingBros. (Stourbridge), Ltd.	—
Lawson, Walton & Co.	24
Le Personne, L., & Co.	—
Leys Malleable Castings Co., Ltd.	—
Lilleshall Co., Ltd.	—
Lloyds Ironstone Co., Ltd.	—
Longrigg, F. T.	—
Longden, G., & Son	—
Lowood, J. Grayson, & Co. Ltd.	17
Lucas Furnaces	—
Lucy, L. H., & Co.	—
Lysaght, John, Ltd.	—
McGregor, Wm.	26
Macnab & Co.	—
McLain System (Inc.)	—
McNeil, Chas., Ltd.	23
Manchester Furnaces, Ltd.	—
Mann's Steam Cart & Wagon Co., Ltd.	8
Mansfield Sand Co.	—
Marley Hill Chemical Co., Ltd.	—
Martin, Wm., Sons & Co.	—
Mitchell, C. H. W., & Co.	7
Moenich, O., & Co., Ltd.	16
Moorwood, Hedley & Co., Ltd.	2
Motherwell, Wm., & Co.	—
Necol Industrial Collodions Ltd.	27
Newcastle Alloy Co., Ltd.	25
North Lincs. Iron & Coal Co.	—
Parkgate Iron & Steel Co., Ltd.	—
Penman & Co.	—
Perry, Thos., & Son, Ltd.	24
Phillips, J. W., & C. J.	—
Pickard, W., & Co.	—
Pickford, Holland & Co., Ltd.	7
Portway, C., & Son	—
Potter, Cowan & Co.	—
Primrose, T. J.	10
Prior, S. J. Burrell, Ltd.	25
Pneulec Machine Co., Ltd.	—
Railton, Leonard	—
Ritchie Hart & Co.	—
Ritchie, J. & R., Ltd.	16
Roberts, Glazebrook & Co., Ltd.	26
Roberts, Wm., & Son	25
Robson Refractories, Ltd.	9
Roper, E., & Co.	—
Rowat, Alexander & Co., Ltd	26
Sankey, J., & Sons, Ltd.	—
Sankey, J. H., & Son, Ltd.	14
Sheet Metal & Galvanizing Co.	8
Shelton Iron, Steel & Coal Co., Ltd.	—
Shore, Douglas W.	—
Shotts Iron Co.	4
Shropshire Iron Co. Ltd.	19
Sifco, Ltd.	—
Silent Machine Co.	21
Silica Société Anonyme	—
Simm, Martha & Son	25
Smart, H. & H. E.	22
Smith, Albert & Co.	—
Smith, Edward, Ltd.	1
Smith, F., & Co. (Wire Mfs.) Ltd.	—
Smith, Thos., & Sons (Rodley Ltd.)	7
Spermolin, Ltd.	13
Standard Sand Co., Ltd.	1
Staveley Coal & Iron Co., Ltd.	6
Steel Co. of Scotland, Ltd.	30
Stephens & Co.	10
Stevenson, J., Ltd.	22
Stewart, D., & Co., Ltd.	—
Stewarts & Lloyds, Ltd.	30
Stokes, J.	7
Sturtevant Eng. Co., Ltd.	—
Tallis, E.	—
Taylor & Farley, Ltd.	25
Tennent, R. B., Ltd.	24 & 26
Thermit, Ltd.	2
Thomas, G. & R.	—
Thwaites Bros., Ltd.	5
Townley, E., & Sons	—
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Wallwork, Hy., & Co.	—
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Waring Bros.	15
Warner, J., & Sons	—
Watson's (Metallurgists) Ltd.	27
Westinghouse Brake & Saxby Signal Co., Ltd.	—
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West Midland Refining Co.	21
Whittaker, W., & Sons	—
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Wilkie, A. H.	—
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Williams, John (Birmingham Sand), Ltd.	—
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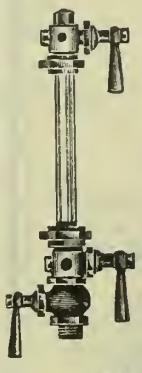

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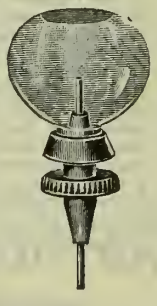

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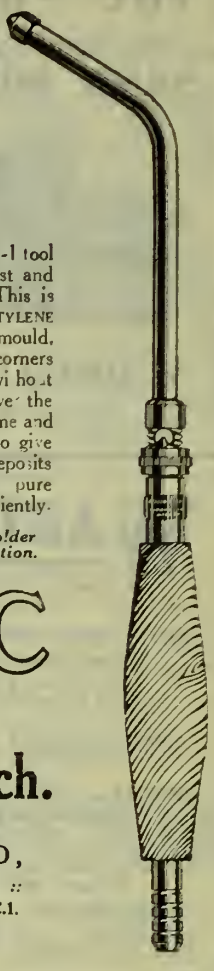

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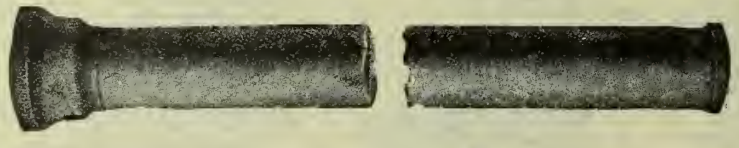

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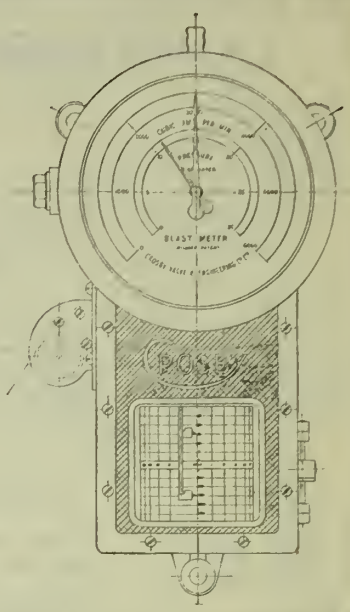

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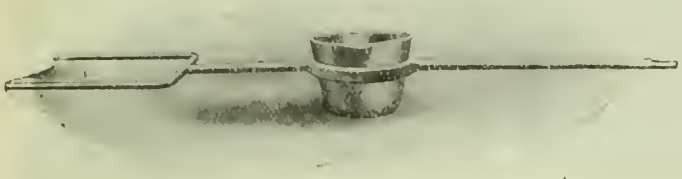

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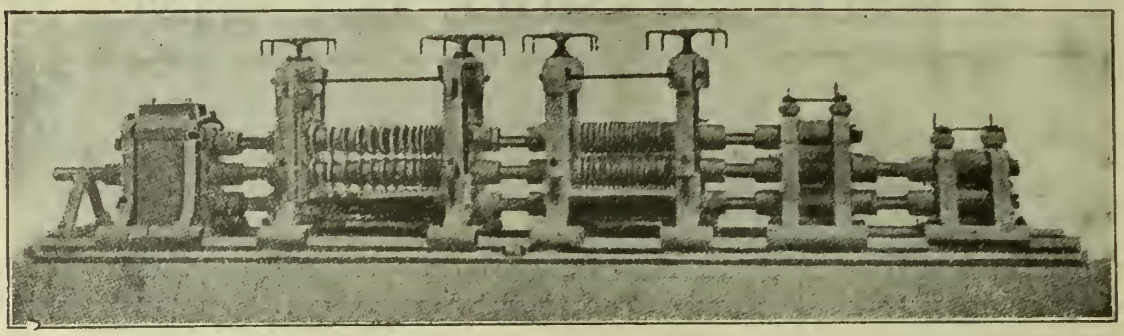

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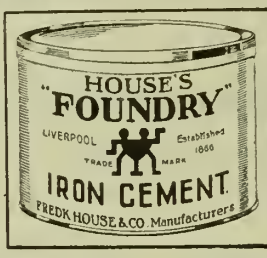

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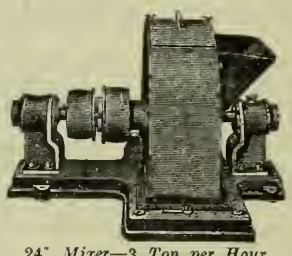

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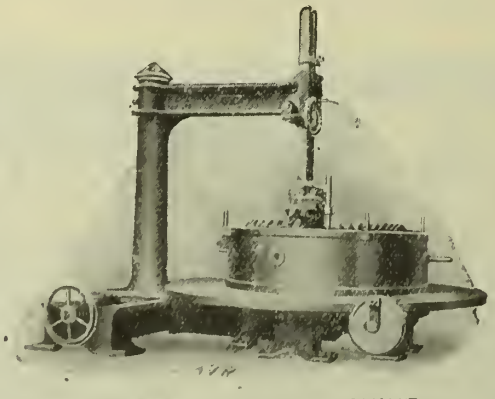
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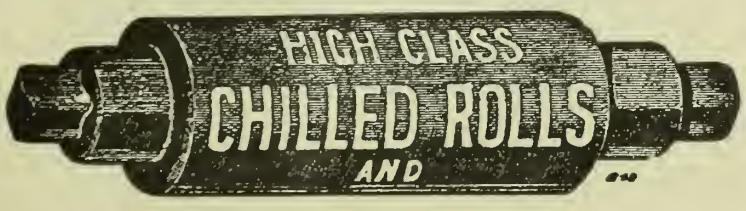

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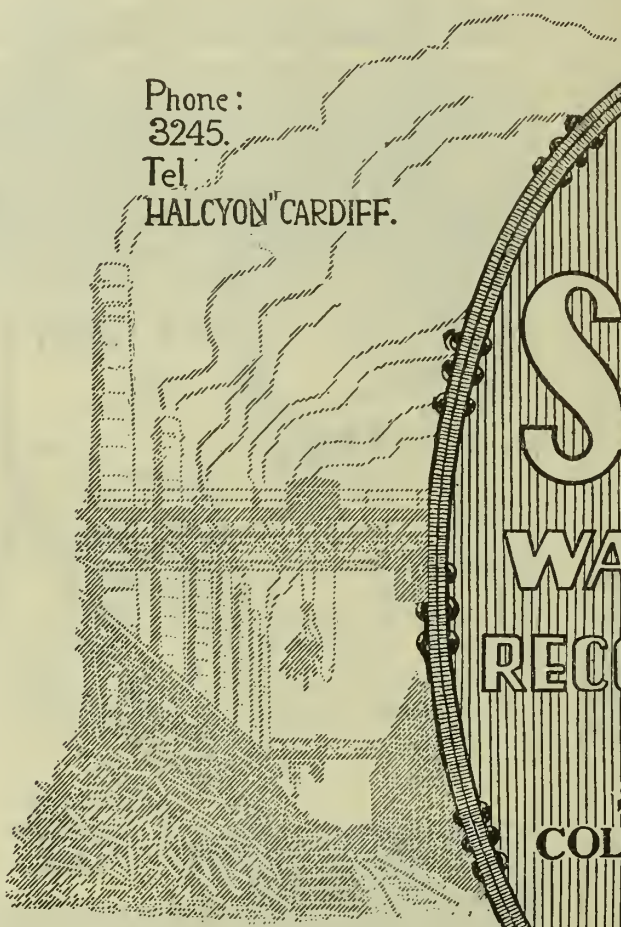

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